“Skilling is building a better India. If we have to move India towards development then Skill Development should be our mission.”

Shri Narendra Modi
Prime Minister of India
Acknowledgements

The content of this Facilitator Guide is aligned to the curriculum of QP/NOS Machining and Quality Technician (ASC/Q3509).

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We would also like to acknowledge the contributions of each and every stakeholder/ individual who have contributed directly or indirectly to the ideas presented in this guide.
Indian Auto Industry is already one of the largest in the world and growing rapidly. As per Automotive Mission Plan 2016-26 the industry is projected to increase its contribution from current level of ~7% of GDP to ~10% in the next decade. In the process, the sector will create 65 million additional jobs. The Automotive sector offers opportunities for a variety of skills.

Employment or self-employment opportunities exist in every nook and corner of the country. Moreover, in line with the technological advancement in this field, there are several exciting options for a candidate to have a fulfilling career.

This guide is designed for the facilitator help a candidate to acquire skills in Manufacturing domain for the job role of a Machining and Quality Technician. The skilling content in the guide is as per industry’s requirements and therefore will be helpful in employment and career advancement or selfemployment. The content of this guide is aligned to the National Occupational Standards (QP/NOS) and conforms to the National Skills Qualifications Framework (NSQF).

- ASC/N3504 Assist in Carrying out pre-machining activities
- ASC/N3505 Support the operator in performing machining operations
- ASC/N3506 Support the operator in conducting all post machining operations
- ASC/N6301 Inspect and maintain the product quality
- ASC/N0006 Maintain a safe and healthy working environment
- ASC/N0021 Maintain 5S at the work premises

ASDC team wishes best of learning to candidates!
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1. Introduction

Unit 1.1 – Industry Brief
Key Learning Outcomes

At the end of this module, you will be able to:

1. Understand the functioning of the automotive industry;
2. Understand the importance of computer operation in the manufacturing sector;
3. Understand the nature of job role.
UNIT 1.1: Industry Brief

Unit Objectives

At the end of this unit, you will be able to:

1. Understand the functioning of the automotive industry;
2. Understand the importance of computer operation in the manufacturing sector;
3. Understand the nature of job role.

Resources to be Used

- Facilitator can use the available objects such as a marker, duster, pen, notebook etc.

Do

- Take a parcel, mention some details such as student name, hobbies, likes, dislikes etc.
- Make the students stand in a circle, close enough to the person each side of them that they can pass the parcel quickly.
- Say ‘Stop’ when the students least expect it. The person who has the parcel at that time should get out from the class.
- Those who get out should introduce themselves by providing the details mentioned in the parcel.
- The winner of the game should stand and introduce himself/herself at the end of the game.
- At last, say thanks to the students for their participation.
- Ask for feedback on the exercise of participation and what they derived out of it.

Notes for Facilitation

- You could ask the students who get out during the game to be the music keepers. They can start and stop the music as the game progresses.
- Encourage shy students to provide information about themselves by prompting them with questions such as ‘what do you enjoy doing the most’, ‘what is your favorite movie or book’ etc.
- Ask the students about the expectations from the course.
- Invite students to participate. List the expectations on the whiteboard.
- Give the students a brief overview of what all will be covered in the program.
- Start with a positive and happy note.
What they understand by the word machining.

What they know about machine tool sector and CNC machine.

At present, the machine tool sector which is a significant sector of the manufacturing industry is operating at a capacity of 90% and above.

Industry experts reported an increase in capacity utilization as compared to 2010 with a growth in capacity in next six months by around 50%.

What they know about job of CNC machine and CNC machine operator.

A CNC machine is automated and run by a computer program used in the engineering industry for cutting metal parts. CNC machines drill, cut and shape highly precise items that are used in numerous industries, such as the automotive and aerospace industries.

A range of products are built by computer control programmers and operators with the aid of computer numerically controlled (CNC) machines. The products range from automobile engines to computer keyboards.

Role of Computer Numerical Control Machines (CNC) in the Manufacturing Sector

CNC find a lot of application in the manufacturing industry. Tools like laser cutting machines, press brakes, roll forms, printing presses and lathe are CNC machines. CNC machines use similar procedures as many other mechanical manufacturing machines but are controlled by a central computer instead of a human operator or electric switchboard.

A computer-controlled module provides the CNC machine with the code, which spells out the functions of forming and shaping that the machine tool must undertake.

The productivity of old-fashioned machines can be improved by retrofitting them with computer control.

CNC programmers, also referred to as numerical tool and process control programmers—develop the programmes and run the machine tools. They define the order of events required to manufacture a part after careful study of three-dimensional computer-aided/automated design (CAD) blueprints of a part. This may involve calculating where to cut or bore into the work piece, how fast to feed the metal into the machine, and how much metal to remove.

CNC Operators prepare the machine for the job on metal and plastic following the completion of the programming work. Preparation of the machine involves

- downloading the programme,
- loading the appropriate tools and
- positioning the workpiece on the CNC machine tools like Spindle, Lathe, Lathe machine, or another machine and then start the machine.
Ask

- Ask them about their understanding for machining sector.
- Ask about CNC machines and their understanding as a CNC machine operator.

Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
2. Job Understanding

Unit 2.1 – Unit Conversion
Unit 2.2 – Basic Geometry – 2D
Unit 2.3 – Basic Geometry - 3D
Unit 2.4 – Reading Engineering Drawing
Unit 2.5 – Precision Measurement - Venier Calliper
Unit 2.6 – Precision Measurement - Micrometer
Unit 2.7 – Precision Measurement - Other Instruments
Unit 2.8 – Precision Measurement - Gauges
Unit 2.9 – Understanding Materials
Unit 2.10 – Machine Optimization
At the end of this module, you will be able to:

1. Explain measurements terms (length, weight, time, etc.);
2. Explain the different measurement systems;
3. Convert values between the measurement systems;
4. Identify the different 2D geometrical shapes;
5. Identify the different 3D geometrical shapes;
6. Differentiate between 2D and 3D shapes;
7. Read engineering drawings;
8. Use the different measuring instruments;
9. Identify the parts of the Micrometer;
10. Explain the working principle;
11. Use the different measuring instruments
12. Use the different types of fixed gauges.
13. State the basic properties of materials (hardness, ductility, toughness).
UNIT 2.1: Unit Conversion

Unit Objectives

At the end of this unit, you will be able to:

1. Explain measurements terms (length, weight, time, etc.);
2. Explain the different measurement systems;
3. Convert values between the measurement systems.

Resources to be Used

- Available objects such as white Board, white board marker pens, duster, participant manual.
- PC with LCD Projector or Flip Chart

Do

- Greet and welcome the participants to the next session of the program.
- Before starting the session ask them do they have any doubts pertaining to the previous unit.
- Capture their responses on board and share them wherever necessary.

Say

- To complete a task you need to take critical measurements based on dimensions set forth in the Engineering Drawings. In addition to this, you need to implement any needed adjustments. Thus, it is extremely important for you to understand how to measure things.
- A measurement unit shows the size or amount of something. In order to complete your job you need to know all about the measurements such as width, length, height, weight and time.
- There are three common systems of measurement:
  1. The centimeter–gram–second system (CGS system);
  2. The meter-kilogram-second (MKS system);
  3. The foot–pound–second system (FPS system).
- A unit of measurement is a definite magnitude of a physical quantity (length, Mass and Time).
- A unit of measurement is definite
**Elaborate**

**Length**
This is important for lots of different reasons. Measurement of length helps you measure the distance between any two points, or how long and tall things are. The most common measurements of length are centimeters, Kilometers, inches, feet, yards and miles.

**Weight**
The weight of an object does not depend on its size. For instance, a large plastic ball may be lighter than a small ball made of iron. Kilogram is one of the common measurements of weight, but we use grams to weigh lighter things.

**Time**
Clocks and watches use hands to show us the hours and minutes. The little hand shows the hours and is called the hour hand. While the big hand shows the minutes and the biggest hand shows us the seconds. These are called the minute and second hand respectively.
When the second’s hand makes a full round that is 60 seconds the minute hand moves one point. So, 60 seconds is equal to one minute. When the minutes hand makes a full round that is 60 minutes, it makes 1 hour. So, 60 minutes is equal to 1 hour. Thus, 15 minutes is one quarter of an hour and 30 minutes is half an hour.
There are two major ways to show the time: “24 Hour Clock” or “AM/PM”.
With the 24 Hour Clock the time is shown as how many hours and minutes have passed since midnight. So, if I were to convert 1 pm to the 24 Hour Clock, I would say it is 13 hundred hours (13:00).

**Different Measuring Unit**
1. **The centimeter–gram–second system (CGS system)**, is a system of units built on the three fundamental units - centimeter as the unit of length, gram as a unit of weight, and second as a unit of time.
2. **The meter-kilogram-second (MKS system)** is a physical system of units that expresses any given measurement using fundamental units of the meter, kilogram, and second.
3. **The foot–pound–second system (FPS system)** is based on foot for length, pound for weight and second for time. Pound can be used instead of kilogram to measure weight.

**Unit Conversion**

<table>
<thead>
<tr>
<th>CGS / MKS</th>
<th>FPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 centimeter (cm)</td>
<td>0.4 inch</td>
</tr>
<tr>
<td>1 meter (100 cm)</td>
<td>3.3 feet</td>
</tr>
<tr>
<td>1 kilometer (1000 m)</td>
<td>0.6 mile</td>
</tr>
<tr>
<td>1 gram (gm)</td>
<td>0.002 ounce</td>
</tr>
<tr>
<td>1 kilogram (1000 g)</td>
<td>2.2 pounds</td>
</tr>
</tbody>
</table>

*Table 2.1.1: Unit Conversion: CGS/ MKS to FPS*
Ask

- You could ask the definition of Unit.
- Ask about systems of measurement.
- Ask about different types of units.

Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.

Table 2.1.2: Unit Conversion: FPS to CGS/MKS

<table>
<thead>
<tr>
<th>FPS</th>
<th>CGS/MKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inch</td>
<td>2.5 centimeter</td>
</tr>
<tr>
<td>1 foot</td>
<td>0.3 metre</td>
</tr>
<tr>
<td>1 mile</td>
<td>1.6 kilometer</td>
</tr>
<tr>
<td>1 ounce (oz)</td>
<td>28 grams</td>
</tr>
<tr>
<td>1 pound (lb)</td>
<td>0.5 kilogram</td>
</tr>
</tbody>
</table>
UNIT 2.2: Basic Geometry – 2D

Unit Objectives

At the end of this unit, students will be able to:

1. Identify the different 2D geometrical shapes.

Resources to be Used

- Facilitator can use the available objects such as a marker, duster, pen, notebook, participant manual etc.

Do

- Greet and welcome the participants to the next session of the program.

Say

- In this session we learn about component drawings and 2D shapes of geometry. A component drawing is a blueprint of product desired.
- It is very important to define the geometry of the part to be manufactured. These geometrical shapes on the component drawing will provide us with the details of the design – like the exact shape and dimensions.
- To understand drawings first we need to clear basics of geometry.

Elaborate

Line, Line Segment and Ray

<table>
<thead>
<tr>
<th>Diagram</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Line Diagram" /></td>
<td>Line - Infinitely continuous in both directions</td>
</tr>
<tr>
<td><img src="image" alt="Ray Diagram" /></td>
<td>Ray - With one end point and other end extends in one direction</td>
</tr>
<tr>
<td><img src="image" alt="Line Segment Diagram" /></td>
<td>Line segment - Has two end points</td>
</tr>
</tbody>
</table>

Table 2.2.1: Line, Line Segment and Ray
Angle

<table>
<thead>
<tr>
<th>Type of Angle</th>
<th>Diagram</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute Angle</td>
<td><img src="angle-acute.png" alt="Diagram" /></td>
<td>An angle that is less than 90°</td>
</tr>
<tr>
<td>Right Angle</td>
<td><img src="angle-right.png" alt="Diagram" /></td>
<td>An angle that is 90° exactly</td>
</tr>
<tr>
<td>Obtuse Angle</td>
<td><img src="angle-obtuse.png" alt="Diagram" /></td>
<td>An angle that is greater than 90° but less than 180°</td>
</tr>
<tr>
<td>Straight Angle</td>
<td><img src="angle-straight.png" alt="Diagram" /></td>
<td>An angle that is 180° exactly</td>
</tr>
<tr>
<td>Reflex Angle</td>
<td><img src="angle-reflex.png" alt="Diagram" /></td>
<td>An angle that is greater than 180°</td>
</tr>
</tbody>
</table>

*Table 2.2.2: Types of Angles*

**Parallel Lines**
When two line segments do not intersect each other they are called parallel lines. For instance, take this diagram, AB is parallel to CD. It is represented as AB//CD.

![Fig. 2.2.1: Parallel Lines](parallel_lines.png)

**Triangle**
A triangle has three sides and three angles. Take a look at this triangle I have drawn here. It has three sides and angles. A, B and C are the three vertices in the triangle. AB, BC and CA are the sides of the triangle.

![Fig. 2.2.2: Triangle](triangle.png)
Types of triangle

| Scalene Triangle: All the sides of the triangle are not equal |
| Isosceles Triangle: Two sides of the triangle are equal |
| Equilateral Triangle: All the sides of the triangle are equal |

Table 2.2.3: Types of Triangles

| Right Angle Triangle: |
| Has a right angle (90°) |
| AB is called perpendicular. |
| BC is called base. |
| AC is called Hypotenuse. |

| Acute Angle Triangle: |
| All angles are less than 90° |

| Obtuse Angle Triangle: |
| Has an angle more than 90° |

Table 2.2.4: Angles of Triangles
Quadrilaterals
Quadrilateral just means “four sides”, wherein quad means four, lateral means side.

Special types of quadrilaterals

<table>
<thead>
<tr>
<th>Trapezium:</th>
</tr>
</thead>
<tbody>
<tr>
<td>A trapezium is a quadrilateral with one pair of sides parallel to each other.</td>
</tr>
<tr>
<td>The parallel sides that are AB and CD are called bases of the trapezium.</td>
</tr>
<tr>
<td>The non-parallel sides are called legs of the trapezium.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parallelogram:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The opposite pair of the quadrilateral is parallel and equal to each other.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rhombus:</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is a parallelogram where all the sides are equal to each other. The diagonals are also equal to each other.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rectangle:</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is a parallelogram with opposite sides equal and adjacent sides perpendicular to each other.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Square:</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is a parallelogram with all sides equal. The adjacent sides are perpendicular to each other.</td>
</tr>
</tbody>
</table>
### Polygons

<table>
<thead>
<tr>
<th>Polygons</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pentagon</td>
<td>Shape with 5 sides</td>
</tr>
<tr>
<td>Hexagon</td>
<td>Shape with 6 sides</td>
</tr>
<tr>
<td>Heptagon</td>
<td>Shape with 7 sides</td>
</tr>
<tr>
<td>Octagon</td>
<td>Shape with 8 sides</td>
</tr>
<tr>
<td>Nonagon</td>
<td>Shape with 9 sides</td>
</tr>
<tr>
<td>Decagon</td>
<td>Shape with 10 sides</td>
</tr>
</tbody>
</table>

*Table 2.2.6: Polygons*
### Circles / Elliptical Shapes

- **The Radius** is the distance from the center to the edge.

![Radius](image)

- **The Diameter** starts at one side of the circle, goes through the center and ends on the other side.

![Diameter](image)

- The distance all around the circle is called the **Circumference** of the circle.

![Circumference](image)

*Table 2.2.7: Circles / Elliptical Shapes*

---

#### Ask

- Ask about importance of component drawings.
- Ask about different 2D shapes of basic geometry.

---

#### Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
At the end of this unit, students will be able to:

1. Identify the different 3D geometrical shapes;
2. Differentiate between 2D and 3D shapes.

Unit Objectives

Resources to be Used

- Facilitator can use the available objects such as a marker, duster, pen, notebook, participant manual etc.
- PC with LCD Projector or Flip Chart

Do

- Greet and welcome the participants to the next session of the program.

Say

- In this session we learn about 3D shapes of geometry.
- A square is a 2D (two dimensional) shape, whereas a cube is a 3D (three dimensional) shape.
- All 2D shapes are those which can be made on a plane surface. A 2D shape has no thickness. Like this rectangle I have drawn on a plane piece of paper. Whereas, a 3D shape like cube has three dimensions: breadth, length and thickness.
- Axis is a reference line drawn on a graph. The horizontal line is generally known as X. The vertical line is generally known as Y. The point where X and Y meet is called origin and generally marked as O.
- 2D shapes can be plotted on X and Y axis. Whereas to plot a 3D shape on the axis, third axis called Z axis is required to accommodate the third dimension of a 3D shape.
- Let’s see some 3D shapes.
### 3-D shapes are:

<table>
<thead>
<tr>
<th>Shape</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cuboid</strong></td>
<td>It is the three dimensional figure of a rectangle. The three dimensions are length, breadth and height.</td>
</tr>
<tr>
<td><strong>Cube</strong></td>
<td>It is the three dimensional figure of a square. All the sides of a cube are equal.</td>
</tr>
<tr>
<td><strong>Cylinder</strong></td>
<td>Cylinder is a three dimensional object with a circular base and straight parallel sides that looks similar to a can of cool drink; Pipes, Solid rods are examples.</td>
</tr>
<tr>
<td><strong>Cone</strong></td>
<td>Cone is a three-dimensional object with a circular base that contracts toward a point. It looks like an ice cream cone.</td>
</tr>
<tr>
<td><strong>Sphere</strong></td>
<td>Sphere is a perfectly round three dimensional shape similar to a round ball you might play sport with.</td>
</tr>
</tbody>
</table>
Prism - When a flat polygon is given a three-dimensional makeover, the result is a prism. A prism possesses five planes – a top, a bottom and three sides. The most common kind of prism is a triangular prism, made by moving a triangle through space.

Multidimensional 3D - Sometimes a 3D object items a single piece combining a cylinder and a cube.

Table 2.3.1: Different 3D Shapes

---

**Ask**

- Ask about difference between 2D shapes and 3D shapes.
- Ask about different 3D shapes of basic geometry.

---

**Notes for Facilitation**

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
At the end of this unit, you will be able to:

1. Read engineering drawings.

Resources to be Used

- Facilitator can use the available objects such as a marker, duster, pen, notebook, participant manual etc.
- PC with LCD Projector or Flip Chart

Do

- Greet and welcome the participants to the next session of the program.
- Before starting the session ask them do they have any doubts pertaining to the previous unit.
- Capture their responses on board and share them wherever necessary.
2.4.1 What is an Engineering Drawing

• An engineering drawing is the technical term that is used to communicate size, shape and features of a desired object.
• The purpose of engineering drawing is to graphically convey the ideas and information necessary for the construction or analysis of component or work piece. Simply said, it is a blueprint of the work piece you will create. It gives you the exact dimensions and tolerances.
• The drawings prepared by any technical person must be clear and leave no scope for misinterpretation, or else confusion may arise.
• A machinist should be able to read the drawing carefully.

2.4.2 Methods of Representation

• There are two ways an engineering drawing can be represented: 2D Drawing and 3D Drawing.
• **2D Drawing**: Two dimensional is a concept that describes anything that composes of length and width. An object is regarded as two dimensional if it has two coordinates, which define the points within it. This is a mathematical and physics concept.
• **3D Drawing**: Three dimensional is a concept that describes anything that composes of length, width, breadth. An object is regarded as three dimensional if it has three coordinates, which define the points within it. This is a mathematical and physics concept.

1.4.3 Lining

• There are many type of lines used in engineering presentation. These have a great importance as they give different message similar to the different expression in our voice during conversation.
Typical standards of lines are summarized below.

1. Visible – A visible line is a continuous line used to show edges that are directly visible from a certain angle. For instance, consider part outlines and section lines.
2. Hidden – A hidden line is short-dashed lines that may be used to denote edges that are not directly visible.
3. Center – A center line is alternately long- and short-dashed lines that may be used to denote the axis of circular features.
4. Cutting plane – Cutting plane lines are thin, medium-dashed lines, or thick alternately long- and double short-dashed that may be used to outline sections for section views.
5. Section – Section lines are thin lines in a pattern used to denote surfaces in section views resulting from “cutting.” Section lines are generally known as “cross-hatching.”

<table>
<thead>
<tr>
<th>Part Outlines</th>
<th>Heavy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section Lines</td>
<td>Light</td>
</tr>
<tr>
<td>Hidden Lines</td>
<td>Medium</td>
</tr>
<tr>
<td>Center Lines</td>
<td>Light</td>
</tr>
<tr>
<td>Dimension and Extension Lines</td>
<td>Light 3.000</td>
</tr>
<tr>
<td>Cutting Plane</td>
<td>Heavy</td>
</tr>
<tr>
<td>Break Lines</td>
<td>Heavy</td>
</tr>
<tr>
<td></td>
<td>Light</td>
</tr>
</tbody>
</table>

*Fig. 2.4.1: Drawing Line Types*

Lines can also be classified by a letter classification in which each line is given a letter.

- **Type A** lines show the outline of the feature of an object. They are the thickest lines on a drawing and done with a pencil softer than HB.
- **Type B** lines are dimension lines and are used for dimensioning, projecting, extending, or leaders. A harder pencil should be used, such as a 2H.
- **Type C** lines are used for breaks when the whole object is not shown. They are freehand drawn and only for short breaks. 2H pencil.
- **Type D** lines are similar to Type C, except they are zigzagged and only for longer breaks. 2H pencil.
- **Type E** lines indicate hidden outlines of internal features of an object. They are dotted lines. 2H pencil.
• **Type F** lines are Type F[typo] lines, except they are used for drawings in electro technology. 2H pencil.
• **Type G** lines are used for centre lines. They are dotted lines, but a long line of 10–20 mm, then a gap, then a small line of 2 mm. 2H pencil.
• **Type H** lines are the same as Type G, except that every second long line is thicker. They indicate the cutting plane of an object. 2H pencil.
• **Type K** lines indicate the alternate positions of an object and the line taken by that object. They are drawn with a long line of 10–20 mm, then a small gap, then a small line of 2 mm, then a gap, then another small line. 2H pencil.

---

**Ask**

• You could ask about the different lines used in engineering drawing
• Ask about different categories of lines.

---

**2.4.4 Dimensioning**

**Say**

• In addition to a complete shape description of an object, a drawing of the design must also give a complete size description.
• The process of writing or giving measurement of the object on a prepared drawing is known as dimensioning.
• Every engineering drawing should show complete size descriptions stating length, width, thickness, diameter of holes grooves etc and such other detail related to its construction.
• The correct placement of dimensions is strictly prescribed by an extensive list of drawing conventions.
• **Dimension line:** A dimension line is a thin, dark line broken in the middle to allow the placement of the dimension value, with arrowheads at each end.
• **Dimension text:** The dimension text denotes the dimension value.
• **Extension line:** An extension line is a thin, dark line that extends from a point on the drawing to which a dimension refers.

![Fig. 2.4.2: Lines Used in Dimensioning](image-url)
2.4.5 Scale Specification

- **Arrowhead**: An arrowhead indicates the extent of dimensions. It is approximately 3 mm long and 1 mm wide. That is, the length is roughly three times the width.
- **Leader**: A leader is a thin, dark, solid line that leads from a note of dimension and terminates in an arrowhead on a line or edge of a hole.

R.F. = Length of an object in drawing / Actual length of the object

2.4.6 Sectioning

- There are many times when the interior details of an object cannot be seen from the outside.
- This difficulty can overcome by pretending to cut the object on a plane and displaying a “sectional view”.
- The sectional view is used where interior details are too complex to denote using hidden lines on an orthographic or isometric drawing.
There are many types of sectional views:

- **Cross-Section View:** A cross-sectional view showcases a cut-away halve of the object and is another way to portray hidden components. Imagine a plane that cuts vertically dissects the pillow block.

![Fig. 2.4.3: Pillow Block Cross-Sectional View](image)

This cross-sectional view (section A-A one that is orthogonal to the viewing direction), shows the relationships of lengths and diameters in a better way. These drawings are easier to develop than isometric drawings.

- **Half-Section View:** A half-section is a view of an object showing one-half of the view in section.

![Fig. 2.4.5: Front View and Half Section](image)
The diagonal lines on the section drawing are used to denote the area that has been theoretically cut. These lines are called section lining or cross-hatching. The lines are thin and are usually drawn at a 45-degree angle to the major outline of the object. The spacing between lines should be uniform.

A second, rarer, use of cross-hatching is to indicate the material of the object. One form of cross-hatching may be used for cast iron, another for bronze, and so forth.

Sectioning Objects with Holes, Ribs, Etc.
Though the cross-section on the right of figure given below is technically correct, the convention in a drawing is to show the view on the left as the preferred method for sectioning this type of object.

![Fig. 2.4.6: Cross Section]

---

**Ask**

- You could ask about need of sectioning of component drawing
- Ask about different types of sectioning.

**2.4.7 Projection**

**Say**

- Engineers are faced with the challenge of making the manufacturers and builders understand the design, development and structures of machines. Communication must be undertaken in a systematic manner, with the shape, size and structure of machines recorded on plane sheets. However, the
pictorial view does not communicate all the details. As a result, engineers should describe the exact shape using ‘projections’ to ensure accuracy.

- One has to show the drawing from all six sides for the manufacturer to understand the shapes required by us in the finished piece. This six sided view are known as projections.
- At least two orthographic views are required to accurately depict even the most basic object. Typically, an elevation and a plan are used.
- The Elevation typically gives us heights and widths; the plan gives us widths and depths of the object. With these two views, we can imagine the front and top of the object.

**Elaborate**

There are two common ways to project a drawing

- **First Angle Projection Method**: The Bureau of Indian Standards has recommended this method of projection since 1991. In this method, the plan (Top view) comes below the elevation (Front view) after the views are portrayed in their relative positions. The view of the object as seen from the left is drawn to the right of the elevation. The observer and the plane of projection sandwich the object. The plane of projection is assumed to be non-transparent.

- **Third Angle Projection Method**: The US and other countries make use of this method of projection. The plan comes above the elevation, when the views are drawn in their relative positions. The left-hand side view is drawn to the left-hand side of the elevation. The plane of projection is sandwiched between the observer and the object. The plane of projection is assumed to be transparent.

The symbols for First Angle and Third Angle projection are:

<table>
<thead>
<tr>
<th>Projection</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Angle Projection</strong></td>
<td><img src="image" alt="Symbol" /></td>
</tr>
<tr>
<td><strong>Third Angle Projection</strong></td>
<td><img src="image" alt="Symbol" /></td>
</tr>
</tbody>
</table>

*Table 2.4.1: Projections and Symbols*
Tolerancing: Allowance for a specific variation in the size and geometry of part.

Requirement:
- For a perfect output in Precision components;
- Large variation may affect the functionality of the part;
- Small variation will affect the cost of the part.

Importance:
- Requires precise manufacturing;
- Requires inspection and the rejection of parts.

When does Tolerances become important:
- Assemblies: If the dimensions of the part do not possess a specific range of values then the parts will most probably not fit together.
- Interchangeability: If a replacement part is used it must be a duplicate of the original part within certain limits of deviation.

Tolerances are specified by:
- Size – Limits stipulating the permitted variation in each dimension (length, width, height, diameter, etc.) are given on the drawing
- GT (Geometric Tolerancing) – Permits stipulation of tolerance for the geometry of a part separate from its size
- GD&T (Geometric Dimensioning and Tolerancing) – Uses special symbols to control different geometric features of a part

Tolerances specified for size:
Limit Tolerances – (12.75/12.25)

Plus/Minus Tolerances:
1. Unilateral Tolerances - (12.00 + or - xxx)
2. Bilateral Tolerances - (12.00 +xxx/- xxx)
Table 2.4.2: Characteristics & Symbols of Tolerance

Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
UNIT 2.5: Precision Measurement - Venier Calliper

Unit Objectives

At the end of this unit, you will be able to:

1. Use the different measuring instruments.

Resources to be Used

- Facilitator can use the available objects such as a marker, duster, pen, notebook, participant manual, Vernier Calliper etc.
- PC with LCD Projector or Flip Chart

Do

- Greet and welcome the participants to the next session of the program.

Say

- A Vernier calliper is a measuring unit that precisely measures (read) distances measurement more accurately than a normal scale or rule.
- A Vernier Calliper consists of two scales - one is fixed while the other one is movable. The fixed scale is called a main scale which is calibrated on L-shaped frame and carries fixed jaws. The movable scale which is also called vernier Scale slides over the main scale and carries a moveable jaw.
- The Least Count of a Vernier Caliper can be calculated using the formula LC = 1 MSD - 1 VSD (Value of one Main Scale Division - Value of one Vernier Scale Division).

Elaborate

For using vernier caliper, move the position of the pointer on the scale. At the point where the pointer is between two markings, take the reading on the scale.
Parts of a vernier caliper:

1. **Outside Jaw** - To measure outer dia. and width of an object.
2. **Inside Jaw** - To measure inner dia.
3. **Depth Probe** - To measure depth of an object.
4. **Main Scale** - Scale set apart in millimeter (mm)
5. **Main Scale** - Scale set apart in inches
6. **Vernier Scale** - Interpolated estimations in millimeter
7. **Vernier Scale** - Interpolated estimations in inches
8. **Retainer** - Used to lock movable parts

**Reading vernier calliper**

The nth number of MSD that the zero of the vernier scale has crossed + the n’th number of VSD coinciding with the MSD x (the least count of the instrument)

For example, the zero of vernier crossed 34 divisions in main scales so main scale reading is 34 and the 54th line coincides with the main scale. Thus, the Vernier scale reading will be:

\[ 54 \times 0.02 = 1.08 \]

The total reading is 34 + 1.08 = 35.08 mm

Ensure that the line of measurement coincides with the line of scale. In addition to this you must also hold the Vernier Calliper straight and view it perpendicularly.

**Zero Error**

When the zero of the main scale and the zero of the vernier scale doesn’t coincide when the jaws of the Vernier Calipers is completely closed, it is said the instrument has defect of zero error. The zero error is of mainly two types:

1. **Positive zero error**: The zero of the vernier scale lie right to the zero of the main scale.
2. **Negative zero error**: The zero of the vernier scale lie let to the zero of the main scale.
Process to correct the zero error
Say the VSD = 2
Then the error = VSD x LC = 2 x 0.02mm = 0.04mm
- So, in case of Positive Zero Error
  The actual reading = Observed value – Error value = 35.08 – 0.04 = 35.04 mm
- In case of Negative Zero Error
  The actual reading = Observed value + Error value = 35.08 + 0.04 = 36.02 mm

Activity
- Conduct a skill practice activity.
- Ask the students to assemble together.
- Explain the purpose and duration of the activity.
- Set guidelines pertaining to discipline and expected tasks.
- Do the measurement of given object by using vernier caliper

<table>
<thead>
<tr>
<th>Skill Practice</th>
<th>Time</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using vernier caliper</td>
<td>2 hours</td>
<td>Vernier caliper</td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
</table>

Do
- Ask them to get practice the activity alone.
- Go around and make sure they are doing it properly.

Notes for Facilitation
- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
UNIT 2.6: Precision Measurement - Micrometer

Unit Objectives

At the end of this unit, you will be able to:

1. Identify the parts of the Micrometer;
2. Explain the working principle.

Resources to be Used

- Facilitator can use the available objects such as a marker, duster, pen, notebook, participant manual, micrometer etc.
- PC with LCD Projector or Flip Chart

Do

- Greet and welcome the participants to the next session of the program.

Say

- Micrometers are precision measurement devices that are used to measure small dimensions. Micrometer can measure thickness of a wire or thickness of a metal sheet.
- Pitch of the screw is the distance moved by the spindle per revolution. Pitch can be defined as the distance advanced by the screw tip when the head is given one complete rotation.
- The least count is the smallest distance that a Micrometer can measure accurately

Elaborate

Body parts of a Micrometer

- **Frame**: Frame of a micrometer is a C-shaped component that clamps the other parts of the micrometer. The frame is usually made of drop-forged steel and is heavy with high thermal mass. The high thermal mass is to prevent heating up and to reduce flexion, expansion and contraction.
- **Anvil**: The projected portion of the frame, which extends to at least 3mm, is known as anvil. It is one of the measuring faces. An anvil is manufactured from alloy steel and in finished to a perfectly flat surface.
• **Spindle:** The spindle of a micrometer grips the job against the anvil. The movement of the thimble causes the spindle to move towards the anvil.

• **Sleeve:** It is also known as barrel or stock. Sleeve is a stationary round part on which datum line and graduations are marked.

• **Thimble:** It is a cylindrical cover attached to the spindle and moves with the spindle. It is has a beveled edge and is divided into 50 equal parts. The divisions are marked as 0, 5, 10, 15....... 45.

• **Ratchet Stop:** It is an extension to the thimble. Ratchet stop ensures even pressure between the gauging surfaces.

• **Lock Lever or Lock Nut:** It is used to lock the spindle at a desired position.

**Pitch**

Pitch of the screw is the distance moved by the spindle per revolution. For instance, the Screw Gauge has a pitch of 0.5 mm. Hence in this case, the spindle moves forward or backward by 0.5 mm when the screw completes a revolution. This spindle’s movement is seen on an engraved linear millimeter scale on the sleeve of the device.

**Least Count**

_{Least count} = \frac{\text{Pitch of Screw Gauge}}{\text{No. of head scale divisions}}

**For Example:**

- Pitch = 1 mm
- No. of head scale division = 100
- Least count = \frac{1}{100} = 0.01 mm

**Zero Error**

If the zero mark of the circular scale does not correspond with the zero mark on the base line of the main scale, then the device is said to have a zero error. The zero error can be both positive and negative.

- **Positive Zero Error** - when zero of the head scale is below the reference line of the main scale.
- **Negative Zero Error** - when zero of the head scale is above the reference line of the main scale.
**Demonstrate**

Calculating the pitch

- **Step 1:** Ensure the zero of the head scale coincides with a definite division on the main scale.
- **Step 2:** Rotate the screw five times.
- **Step 3:** Observe the distance moved by the main scale.

Calculating zero error

**Positive zero error**

1. Note the division on the head scale coinciding with the zero of the main scale.
   
   *For example:* The 1st division of the head scale is coinciding with the reference line of the main scale. As the zero of the head scale is below the reference line, this is a positive zero error.

2. Multiply the coinciding head scale division with the least count.
   
   \[
   \text{Zero Error} = \text{Coinciding Head Scale} \times \text{Least count}
   \]
   
   \[
   \text{Zero Error} = 1 \times 0.01 = +0.01\text{mm}
   \]
   
   \[
   \text{Zero Correction} = -0.01\text{mm}
   \]

3. Add the zero correction with the observed reading to obtain the actual reading.
   
   \[
   \text{Actual reading} = \text{Observed reading} + \text{zero correction} (-0.01\text{mm})
   \]

**Negative zero error**

1. Note the division on the head scale coinciding with the zero of the main scale.
   
   *For example:* The 98th division of the head scale is coinciding with the reference line of the main scale. As the zero of the head scale is below the reference line, this is negative zero error.

2. Subtract the coinciding division with the total number of divisions on the head scale.
   
   \[
   \text{Total No. of divisions} = 100
   \]
   
   \[
   \text{Coinciding division} = 98
   \]
   
   Subtract 98 from 100 gives us 2 as balance.

3. Multiply the coinciding head scale division which is 2 with the least count.
   
   \[
   \text{Zero Error} = \text{Coinciding Head Scale} \times \text{Least count}
   \]
   
   \[
   \text{Zero Error} = 2 \times 0.01 = 0.02\text{mm}
   \]

4. Assign a negative sign to the zero error as it is negative zero error.
   
   \[
   \text{Zero Error} = 2 \times 0.01 = -0.02\text{mm}
   \]
   
   \[
   \text{Zero Correction} = +0.02\text{mm}
   \]
5. Add the zero correction with the observed reading to obtain the actual reading.

Actual reading = Observed reading + zero correction (0.02mm).

**Reading diameter of a wire**

1. Calculate the least count.
   
   **Least count** = Pitch of Screw Gauge/ No. of head scale divisions
   
   Let least count be 0.01mm.

2. Calculate the zero error.
   
   **Zero Error** = Coinciding Head Scale x Least count

3. Place the given wire in between the stud and the flat end.

4. Rotate the screw till the wire is firmly gripped by the both ends.

5. Note the main scale reading and the head scale reading.

6. Calculate the diameter of the wire with the given formula.
   
   **Actual Diameter** = Observed Diameter + Zero Correction

7. Repeat the above steps three to five times and take the average of the obtained outcomes. This will be the actual diameter.

---

**Activity**

- Conduct a skill practice activity.
- Ask the students to assemble together.
- Explain the purpose and duration of the activity.
- Set guidelines pertaining to discipline and expected tasks.
- Do the measurement of given object by using micrometer

<table>
<thead>
<tr>
<th>Skill Practice</th>
<th>Time</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using micrometer</td>
<td>2 hours</td>
<td>Micrometer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Any object for measurement</td>
</tr>
</tbody>
</table>
Do

- Ask them to get practice the activity alone.
- Go around and make sure they are doing it properly.

Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
At the end of this unit, you will be able to:

1. Use the different measuring instruments.

Resources to be Used

- Facilitator can use the available objects such as a marker, duster, pen, notebook, participant manual, measuring instruments etc.
- PC with LCD Projector or Flip Chart

Do

- Greet and welcome the participants to the next session of the program.

Say

- Interchangeability is something or part that can be interchanged or replaced with a new one.
- Tolerance is the maximum allowed limit to which a dimension can be stretched.
- In lathe operations, machine tool quality, quality of material, RPM of the machine, feed of the tool, the ambient temperature of the room all play a role to contribute towards the final dimension of a turned piece. Thus all the dimensions of all pieces turned may not always be the same.
- Within a tolerable limit; variation in a dimension is acceptable because it falls within the parameter of interchangeability.
- In machining, there are various measurements that can be done by standard measuring instruments like micrometer, height gauge etc. For the purpose of consistency in manufactured output and ensuring the output within tolerances, certain methods of controlling the same are required.
- There are three types of measurement checking devices which are categorized into three basic categories:
  1. Variable - The variable ones are vernier calipers, internal and external micrometers, height gauge, dial gauges, angle protectors.
  2. Fixed - The fixed ones include Go-no go gauges, snap gauges, slip gauges, thread gauge, tri-square gauge.
  3.Contours - The contours refer to special shapes of any types primarily for non standard special items.
Dial Gauge
The Dial Gauges are very fine measuring instruments for gauging the variance. These are single point touch ball mounted on the nose of a dial gauge, which when pushed or pulled shows deflection of the needle, which can be measured. The dial gauge will show both positive and negative deflection; moreover the deflection can be quantified and measured. The least count of these devices can be as low as one micron millimeter.
Puppy Dial Gauge which is much smaller than the normal dial gauge and because of its smaller size and lighter weight it is used more often and specially in applications where there is less space to work.

Height Gauge
Height gauge is used to determine the height of an object. It can also be used to generate repetitious marking on objects. This measuring tool is used in metal working or metrology to either set or measure vertical distances. The pointer is sharp, allowing it to work as a scriber and helping in marking out work pieces.
It has simple construction which consists of a base which remains in contact with surface plate. The main scale is inserted and fixed on the base. This main scale also serves as rail on which vernier scale assembly slides up and down. There is a locking screw with which we can lock position of vernier scale assembly with respect to main scale. Above it there is a fine adjustment screw which we can adjust zero of vernier scale while assembly is locked by lock no-1. You can adjust height of probe while second part is fixed by lock -2.
The height of an object can be measured by using the bottom of the height gauge’s scriber as the datum. The height gauge may allow for adjustments to the scale or the datum may be permanently attached. Adjustments can be made by moving the scale vertically along the frame of the height gauge with a fine feed screw. As a result, the scale can be matched to the scriber.

Internal Micrometer
The Internal micrometer is used to measure holes and bores only of precise size, the micrometers are available in steps say 0-25mm, 25-50mm and so on.
They can even accurately measure gaps between two planes, inside dimension of a square and a slot.
Show the different measuring instruments like dial gauge, height gauge, internal micrometer to trainees in workshop.

Demonstrate how to operate these measuring instruments to trainees.

Conduct a skill practice activity.

Ask the students to assemble together.

Explain the purpose and duration of the activity.

Set guidelines pertaining to discipline and expected tasks.

<table>
<thead>
<tr>
<th>Skill Practice</th>
<th>Time</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using dial gauge, height gauge, internal micrometer</td>
<td>2 hours</td>
<td>Dial gauge, height gauge, internal micrometer</td>
</tr>
</tbody>
</table>

Ask them to get practice the activity alone.

Go around and make sure they are doing it properly.

Summarize the main points.

Ask participants if they have any doubts.

Encourage them to ask questions.

Answer their queries satisfactorily.

Tell participants to complete the questions at the end of the unit.

Ensure that every participant answer all the questions.
UNIT 2.8: Precision Measurement - Gauges

Unit Objectives

At the end of this unit, you will be able to:

1. Use the different types of fixed gauges.

Resources to be Used

- Facilitator can use the available objects such as a marker, duster, pen, notebook, participant manual, measurement gauges etc.
- PC with LCD Projector or Flip Chart

Do

- Greet and welcome the participants to the next session of the program.

Say

- As discussed in previous session, gauges are categorized into three categories i.e. movable, fixed and contour.
- So, there are many other more options of gauges generally utilized in workshop.
- Some commonly used gauges are angle gauge, thread gauge, tri-square, snap gauge etc.

Elaborate

Angle Gauge

Angle gauge is a type of fixed gauges. Angle Gauge is also known as Angle Protector. It is an instrument to gauge the angle, it is different from measuring the angle, as this a process of comparison or matching the angle, it is termed as Gauging.

The angle gauges have the following basic shapes / types:

1. **External Angle Gauge**: Used normally for External Angle Gauging however depends upon the application, the use can be accordingly modified.

2. **Internal Angle Gauge**: Used normally for Internal Angle Gauging however depends upon the application, its usage can be accordingly modified.
Thread Gauge

The threads are of various types and pitches, depending on the use. However, there are some commonly used thread types with standard pitch, the thread gauges are used to gauge the same.

Types of thread gauges:

1. **External Thread Gauges**: The External Thread Gauges are used to compare the pitch and the shape of the thread with respect to the Specified Thread Gauge.

2. **Internal Thread Gauges**: In case of Internal Thread Gauge, there are Go and No-Go thread gauges of that particular thread as required with the specific Type, dia. and Pitch for the thread.

Tri-square Gauge

Tri-square gauge looks like a L-shaped Scale. is used normally to gauge 90 degree angle both internal and external.

---

**Do**

- Show the different measuring instruments like angle gauge, thread gauge, tri-square to trainees in workshop.
- Demonstrate how to operate these measuring instruments to trainees.

**Activity**

- Conduct a skill practice activity.
- Ask the students to assemble together.
- Explain the purpose and duration of the activity.
- Set guidelines pertaining to discipline and expected tasks.

<table>
<thead>
<tr>
<th>Skill Practice</th>
<th>Time</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using angle gauge, thread gauge, tri-square</td>
<td>2 hours</td>
<td>Angle gauge, thread gauge, tri-square</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Any object for measurement</td>
</tr>
</tbody>
</table>
Do

• Ask them to get practice the activity alone.
• Go around and make sure they are doing it properly.

Notes for Facilitation

• Summarize the main points.
• Ask participants if they have any doubts.
• Encourage them to ask questions.
• Answer their queries satisfactorily.
• Tell participants to complete the questions at the end of the unit.
• Ensure that every participant answer all the questions.
UNIT 2.9: Understanding Materials

Unit Objectives

At the end of this unit, students will be able to:

1. State the basic properties of materials (hardness, ductility, toughness).

Resources to be Used

- Available objects such as white board, white board marker pens, duster, participant manual etc.
- PC with LCD Projector or Flip Chart

Do

- Greet and welcome the participants to the next session of the program.
- Before starting the session ask them do they have any doubts pertaining to the previous unit.
- Capture their responses on board and share them wherever necessary.

Say

- It is important for operators to know about materials. Being operators you must be familiar with the effects which the manufacturing processes and heat treatment have on the properties of the materials.

- The engineering materials are mainly classified as:
  - Metals and their alloys such as; iron, steel, copper, aluminium, etc.
  - Non-metals such as; glass, rubber, plastic, etc.

- The metals may be further classified as:
  - Ferrous metals: Those metals which have the iron as their main constituent, such as cast iron, wrought iron and steel.
  - Non-ferrous metals: Those which have a metal other than iron as their main constituent, such as copper, aluminum, brass, tin, zinc, etc.

- The properties of metal are divided in two parts:
  - Physical properties of metal and
  - Mechanical properties of metal.
The physical properties of the metals include luster, colour, size and shape, density, electric and thermal conductivity, and melting point.

The ability of a metal to withstand mechanical forces and load is termed as the mechanical property of the said material. These mechanical properties include strength, stiffness, elasticity, plasticity, ductility, brittleness, malleability, toughness, resilience, creep and hardness.

### Physical properties of metal

<table>
<thead>
<tr>
<th>Metal</th>
<th>Metal Density (kg/m³)</th>
<th>Melting Point (°C)</th>
<th>Thermal Conductivity (W/m°C)</th>
<th>Coefficient of Linear Expansion at 20°C (µm/m°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium</td>
<td>2700</td>
<td>660</td>
<td>220</td>
<td>23</td>
</tr>
<tr>
<td>Brass</td>
<td>8450</td>
<td>950</td>
<td>130</td>
<td>16.7</td>
</tr>
<tr>
<td>Bronze</td>
<td>8730</td>
<td>1040</td>
<td>67</td>
<td>17.3</td>
</tr>
<tr>
<td>Cast iron</td>
<td>7250</td>
<td>1300</td>
<td>54.5</td>
<td>9</td>
</tr>
<tr>
<td>Copper</td>
<td>8900</td>
<td>1083</td>
<td>393.5</td>
<td>16.7</td>
</tr>
<tr>
<td>Lead</td>
<td>11,400</td>
<td>327</td>
<td>33.5</td>
<td>29.1</td>
</tr>
<tr>
<td>Monel metal</td>
<td>8600</td>
<td>1350</td>
<td>25.2</td>
<td>14</td>
</tr>
<tr>
<td>Nickel</td>
<td>8900</td>
<td>1453</td>
<td>63.2</td>
<td>12.8</td>
</tr>
<tr>
<td>Silver</td>
<td>10,500</td>
<td>960</td>
<td>420</td>
<td>18.9</td>
</tr>
<tr>
<td>Steel</td>
<td>7850</td>
<td>1510</td>
<td>50.2</td>
<td>11.1</td>
</tr>
<tr>
<td>Tin</td>
<td>7400</td>
<td>232</td>
<td>67</td>
<td>21.4</td>
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<tr>
<td>Tungsten</td>
<td>19,300</td>
<td>3410</td>
<td>201</td>
<td>4.5</td>
</tr>
<tr>
<td>Zinc</td>
<td>7200</td>
<td>419</td>
<td>113</td>
<td>33</td>
</tr>
<tr>
<td>Cobalt</td>
<td>8850</td>
<td>1490</td>
<td>69.2</td>
<td>12.4</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>10,200</td>
<td>2650</td>
<td>13</td>
<td>4.8</td>
</tr>
<tr>
<td>Vanadium</td>
<td>6000</td>
<td>1750</td>
<td>—</td>
<td>7.75</td>
</tr>
</tbody>
</table>
Mechanical properties of the metals

- **Strength**: The ability of a material to not break or yield when facing externally applied forces is termed as the strength of the material.

- **Stiffness**: The ability of a material to not deform when facing stress is known as stiffness. The measure of stiffness is the modulus of elasticity.

- **Elasticity**: It is the ability of the material to return to its original shape following deformation when external forces are suspended. This property is suitable for use in tools. This property of the material is critical for forgings, in stamping images on coins and in ornamental work.

- **Ductility**: It is the ability of a material to allow itself to be drawn into a wire with the use of tensile force. A ductile material must be plastic and strong. Ductility is measured by percentage elongation and percentage reduction in area. Ductile materials commonly used by engineers are mild steel, copper, aluminum, nickel, zinc, tin and lead.

- **Brittleness**: Britteness is the antonym of ductility. It is the ability of a material to break with extremely less permanent distortion. When subjected to tensile loads, brittle materials snap off without providing any elongation. Cast iron is brittle.

- **Malleability**: It is the property of a material that allows it to be hammered or rolled into thin sheets. A malleable material may not be as strong but should be plastic. The malleable materials that are commonly used by engineers are lead, soft steel, wrought iron, copper and aluminum.

- **Toughness**: The ability of a material to withstand fracture due to high impact loads like hammer blows is known as toughness. When exposed to heat, the toughness of the material declines. It is measured by considering the amount of energy that a unit volume of the material absorbs up to the point of fracture. The property is suitable in parts that are exposed to shock and impact loads.

- **Machinability**: This property concerns how easily a material can be cut. Machinability can be measured in several ways. One can check the thrust required to remove the material at some given rate or compare the tool life for cutting different materials. One can also check the energy required to remove a unit volume of the material. Brass is much more easily machined than ordinary steel.

- **Resilience**: It is the ability of a material to withstand shock and impact loads while absorbing energy. The amount of energy absorbed per unit volume within the elastic limit provides the measure of resilience. This property is key for spring materials.

- **Creep**: When a material undergoes slow and permanent deformation due to constant exposure to stress at a high temperature for a long period of time, the material is said to have undergone creep. The property is very important when designing internal combustion engines, boilers and turbines.

- **Fatigue**: The property of a material that causes it to fail at stresses below the yield point stresses after it has been exposed to repeated stress is known as fatigue. Progressive crack formation, which is generally fine and microscopic in nature, is the main cause of such failure. This property is considered in designing shafts, connecting rods, springs, gears, etc.
• **Hardness:** This is a key property of metals and it carries a wide range of meaning. The term covers properties such as resistance to wear, scratching, deformation and machinability etc. It also covers the ability of a metal to cut another metal. The hardness is denoted in numbers and is dependent on the method of the test.

**Cast Iron**

Cast iron is mainly an alloy of carbon and iron. A furnace known as cupola is used to re-melt pig iron with coke and limestone, resulting in the formation of cast iron.

Cast iron contains carbon in either of the following two forms:

1. Free carbon or graphite, and  
2. Combined carbon or cementite

Cast iron is a valuable material for engineering purposes due to the following properties: its low cost, good casting characteristics, high compressive strength, wear resistance and excellent machinability. The compressive strength of cast iron is much higher than its tensile strength.

The values of the ultimate strength of cast iron are:

- **Tensile strength** = 100 to 200 MPa  
- **Compressive strength** = 400 to 1000 MPa  
- **Shear strength** = 120 MPa

**Wrought Iron**

Wrought iron is considered the purest form of iron. Wrought iron is purest as it contains at least 99.5% iron but may contain up to 99.9% iron. The typical composition is:

- **Carbon** = 0.020% , **Silicon** = 0.120%  
- **Sulphur** = 0.018%  
- **Phosphorus** = 0.020%  
- **Slag** = 0.070% and the remaining is iron.

Wrought iron is not a soft metal. It is malleable, tough and ductile. It cannot withstand sudden and excessive shocks. Its ultimate compressive strength is 300 MPa while its ultimate tensile strength is in the range of 250 MPa to 500 MPa. It can be easily forged or welded. It is used for chains, crane hooks, railway couplings, and water and steam pipes.

**Steel**

Steel is an alloy of carbon and iron, with carbon content up to a maximum of 1.5%. The carbon is present through iron carbide and it increases the hardness and strength of the steel.
Carbon steel is defined as steel which has its properties mainly due to its carbon content and does not contain more than 0.5% of silicon and 1.5% of manganese.

The plain carbon steels varying from 0.06% carbon to 1.5% carbon are divided into the following types depending upon the carbon content.

1. Dead mild steel — up to 0.15% carbon
2. Low carbon or mild steel — 0.15% to 0.45% carbon
3. Medium carbon steel — 0.45% to 0.8% carbon
4. High carbon steel — 0.8% to 1.5% carbon

The steel is specified based on minimum tensile strength or yield strength.

The free cutting steels contain sulphur and phosphorous. These steels contain more sulphur than other carbon steels. In general, the carbon content of such steels differs from 0.1 to 0.45 per cent and sulphur from 0.08 to 0.3 per cent. These steels are used where rapid machining is the major requirement. The presence of sulphur and phosphorus results in long chips in machining to be easily broken. As a result, machines are not clogged. Today, lead is used from 0.05 to 0.2 per cent instead of sulphur, as lead also increases the machinability of steel without compromising on toughness.

**Alloy Steel**

The alloying is done for specific purposes to increase wearing resistance, corrosion resistance and to improve electrical and magnetic properties, which cannot be obtained in plain carbon steels.

The chief alloying elements used in steel are nickel, chromium, molybdenum, cobalt, vanadium, manganese, silicon and tungsten. Each of these elements add certain qualities upon the steel to which it is added. These elements may be used separately or in combination to produce the desired characteristic in steel.

**Stainless Steel**

Stainless Steel is among the most commonly used metals. It is the type of steel that withstands corrosion created by most corrosive media and resists oxidation. This phenomenon occurs when the steel is heat treated and finished properly.

**Non-Ferrous Metals**

The non-ferrous metals comprise a metal other than iron as their major component. The non-ferrous metals are used in industry due to the following features:

1. Ease of fabrication (casting, rolling, forging, welding and machining),
2. Resistance to corrosion,
3. Electrical and thermal conductivity and
4. Weight.

Non-ferrous metals that are used in engineering practice are aluminium, copper, lead, tin, zinc, nickel, etc. and their alloys.

Bearing Metals

The most commonly used bearing metals are:

1. Copper-base alloys,
2. Lead-base alloys,
3. Zinc base alloys, and

Ask

- Ask about how to classify materials used in engineering sector.
- Ask students about properties of metals.
- Ask about properties of different types of metals used.

Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
UNIT 2.10: Machine Optimization

Unit Objectives

At the end of this unit, you will be able to:

1. Understand and evaluate the machine optimization process;
2. Calculate the Cycle time taken for production of goods;
3. Understand the factors that ensure the proper utilization of machines.

Resources to be Used

- Available objects such as white Board, white board marker pens, duster, participant manual etc.
- PC with LCD Projector or Flip Chart

Do

- Greet and welcome the participants to the next session of the program.
- Before starting the session ask them do they have any doubts pertaining to the previous unit.

Say

- Machine optimization is a process through which you can get maximum output or production in minimum cost, time achieving the required quality standard.
- Machine optimization improves both machine utilization and check machine underutilization.

Machine Optimization → Machine Utilization
Machine Optimization → No Underutilization

- It is very important to take care of machine optimization to earn good profits and do away with the enemies of profits.
- Cycle time is the time it takes to complete a production run divided by the number of good work pieces produced.
During production runs there may be activities occurring that are not very productive. Anything that adds to the length of time it takes to complete a production run may increase your cycle time.

Factors Fostering Machine Optimization

1. Always use coolant of proper grade for a particular operation for a particular material.
2. Always use feed, speed and depth of cut ratios as recommended by the manufacturer.
3. Use a proper tool for a particular type of operation. Avoid using substitutes of cutting tools.
4. Use proper grade of tools like carbide bit tools for operations; it can take heavier cut and feed. Thus, produce more number of components per hour without affecting wear and tear of machine.
5. Choose correct operation sequence for operation / procedure to manufacturing of any component so that job is done in a single setting and loading. Maximum number of side changes should be not more than two. It will reduce component loading time.
6. We should always mind holding allowance for any job. It will ensure proper clamping of job. Holding length of job should never be less than minimum required length as recommended by the machine manufacturer. Always hold the work piece from center to center if the job is of long size. Otherwise the job bend and may also lead to an accident.
7. If there is a provision of increasing / decreasing force of tail stock then decrease the force; if the machine is thin otherwise the job will bend because of the force of tail stock.
8. Tools should never be over hung because over hanged tool will lead to breakage of tool which may further lead to job rejection and accidents.
9. The work piece should be steady and supported by tail stock.
10. Always load the job within the range of the machine capacity (weight wise). All the machines are designed to support the job load for a particular extent (weight of job). If we load a heavy job on an incapable machine we will never get the required accuracy and finish.
11. Perform roughing operation on a conventional machine and then finish operation on CNC machine.
12. Ensure consistency in the diameter size of the component. This comes from conventional machining, because it will ensure consistency in the depth of cut. If diameter is plus it will lead to more depth of cut thus also damage tool.
13. Always ensure availability of setting tools while doing setting on the machine and measuring tools. It will decrease machine ideal time thus increase production time.
14. Always use proper size of raw material for any job. For any job which has 20mm final size then take 22 mm diameter raw material. If 22 mm diameter suits then do not go for 25mm, 28 mm or higher size. It will increase machining timing and material cost.

15. The finish of pre final and final cuts is important. Do not waste time by low feed and depth of cut.

**Ask**

- Ask students about importance of machine optimization
- Ask about cycle time and how it can be reduce.

**Notes for Facilitation**

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
3. Safety

Unit 3.1 – Personal Protective Equipment (PPE)
Unit 3.2 – Generic Safety
Unit 3.3 – Fire Safety
Unit 3.4 – First Aid for Electric Shock and Burns
Unit 3.5 – 5S
At the end of this module, students will be able to:

1. Wear the Personal Protective Equipment;
2. Observe the safety measures while working;
3. Identify the causes of fire at the shop floor;
4. List the dos and don’ts to prevent fire;
5. Explain how to deal with a fire accident;
6. Describe the different safety precautions at workplace;
7. Describe how to give first aid in case of burns and shocks;
8. Explain importance of 5S;
9. Describe 5S activities.
At the end of this unit, you will be able to:

1. Wear the Personal Protective Equipment.

Resources to be Used

• Available objects such as a duster, pen, notebook, PPE etc.

Do

• Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

• Safety is an action which organizes and controls all our acts in such a manner that one should not get involved, exposed ourselves or others in an accident.

• Accident is an event that is uncontrolled and unplanned where the reaction or action of a person, object, substance or radiation brings about personal injury or the likelihood thereof.

• Personal protective equipment (PPE) serves as the last resort for controlling hazards and is one, but not the only, ancillary or temporary measure.

• To make full and proper use of personal protective equipment (PPE), one should first make sure that the equipment can fulfill the working requirements, conform to the required standards, fit the body shape of the user, be user-friendly, and is under regular maintenance and can be replaced if necessary.

• The PPE in workshop includes workshop coats, safety glasses or goggles, masks and respirators, helmets, safety gloves and shoes.

• Non-disposable facemasks and respirators require regular cleaning and maintenance. To ensure effectiveness, they must first be face-fit tested at the Occupational Health clinic. All PPE should be taken off before leaving the workshop area and entering other areas, such as staff rooms or offices.
Personal Protective Equipment and accessories required

- **Leather Apron**: Leather is worn to protect the welder from spatters during welding and from arc rays.
- **Leather Gloves**: They protect the welder from sparks, arc rays and spatters during welding. Gloves also protect the welder from hot objects.
- **Safety Shoes**: Safety shoes serve as an insulator. They also save the foot from spatters; arc rays and sparks during welding.
- **Safety Helmet**: A safety helmet is worn on the shop floor during grinding etc. to guard the wearer from falling objects or flying splinters.
- **Clear Glass Goggles**: Clear glass goggles are worn during operations like grinding, drilling to protect the eyes from flying splinters.
- **Ear Muffs/Plugs**: They protect you from high noise levels on the shop floor. They also stop any splinters from entering the ears.
- **Dust Mask**: A dust mask is worn to protect the wearer from fine dust which is made up mainly of fine metal particles.

Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
UNIT 3.2: Generic Safety

Unit Objectives

At the end of this unit, you will be able to:

1. Observe the safety measures while working.

Resources to be Used

- Available objects such as a duster, pen, notebook, hazard warning sign etc.

Do

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

- **Unsafe conditions in workshop are:** Lack of proper safeguard on machinery
  - Hazardous arrangement, procedure etc.
  - Improper ventilation
  - Improper illumination
  - Unsafe dress
- **Unsafe acts happen in workshop are:** Using unsafe equipments or equipments unsafely
  - Working or operating at precarious speeds
  - Unsafe loading, placing and combining
  - Taking unsafe position or posture
  - Suspending the operation of safety devices
- It is very important to realize the cost that we have to pay for an accident. Sometimes this cost is irreparable. Besides the loss of life there are other concerns too.
  - Cost of lost time of injured employee
Steps to Prevent Accidents

**Step 1: Dress and Behaviour:**
- Close fitting uniform should be worn in the workshop.
- Do not wear rings, watches, scarves and tie, because they can get caught up in the moving parts of the machinery.
- When operating machine tools, long shirt sleeves should be rolled up.
- Long hair should be tied and covered with a safety cap.
- Safety goggles must be worn while chipping, lathe, grinding, drilling, etc.
- Shoes having oil resistant thick soles should be worn.
- Do not talk to, or otherwise distract anyone who is working with tools or machinery.
- Fooling about in the workshop, especially near machine tools can cause serious injury.
- Keep clear of moving parts of machine and loads being hoisted.
- Never stand under a load supported by lifting device.
- Do not leave a machine unattended while it is running. Do not leave equipments in dangerous positions.
- Use correct gang ways and watch where you walk.

**Step 2: Safety with Hand Tools:**
- Files must never be used as levers. They should always have a proper handle fitted to them. Chisels with mushroom head are dangerous. When chipping always make sure that chips do not hit somebody standing nearby.
- Always hold the work firmly in a vice or other holding device. If the work shifts during

We must take adequate safety measures to prevent accidents. Now, while you process this information, I am going learn about some steps that can prevent accidents. After all, precaution is better than cure.

Elaborate

**Steps to Prevent Accidents**

**Step 1: Dress and Behaviour:**
- Close fitting uniform should be worn in the workshop.
- Do not wear rings, watches, scarves and tie, because they can get caught up in the moving parts of the machinery.
- When operating machine tools, long shirt sleeves should be rolled up.
- Long hair should be tied and covered with a safety cap.
- Safety goggles must be worn while chipping, lathe, grinding, drilling, etc.
- Shoes having oil resistant thick soles should be worn.
- Do not talk to, or otherwise distract anyone who is working with tools or machinery.
- Fooling about in the workshop, especially near machine tools can cause serious injury.
- Keep clear of moving parts of machine and loads being hoisted.
- Never stand under a load supported by lifting device.
- Do not leave a machine unattended while it is running. Do not leave equipments in dangerous positions.
- Use correct gang ways and watch where you walk.

**Step 2: Safety with Hand Tools:**
- Files must never be used as levers. They should always have a proper handle fitted to them. Chisels with mushroom head are dangerous. When chipping always make sure that chips do not hit somebody standing nearby.
- Always hold the work firmly in a vice or other holding device. If the work shifts during
operation a nasty injury may result.

- Always use correct size of spanner and avoid the use of packing or extension handles.
- Always use a screwdriver which fits correctly in the screw head. Do not hold the work in hand while tightening or loosening a screw. The screwdriver may slip and cause injury in hand.

**Step3: Safety with the Machine:**

- Do not try to operate any machine before you fully understand its mechanism.
- Be sure how to stop a machine before you start it. Never operate a machine unless all safety guards are in position.
- Always keep the shop floor free from oil, grease, tools and other cuttings.
- Job must be clamped properly.
- Cutter must be held properly.
- Only recommended speeds and feeds should be used.
- Use cleaning brush to clear off swarf from the machine.
- Do not attempt to measure the job when it is in moving position.
- Do not try to change gears when machine is in running position.
- Do not try to stop rotating tool job by hand.
- Only recommended lubricants and coolants should be used.
- Grinding wheel should be checked for crack before fitting it.
- Switch off power while mounting or dismounting a chuck and removing job from the machine.
- Chuck key must be removed before starting the machine.
- A wooden plank should be used on bed ways of lathe while mounting and dismounting the chuck.
- Get first aid immediately for any injury.

**Appropriate Waste Disposal Methods**

- Place trash and recyclable containers throughout the job site and mark them for proper use.
- Keep waste in metal cans or bins with self-closing covers and remove debris at regular intervals.
- Never allow rubbish to fall freely from any level of the project. Utilise other approved methods or chutes to discard waste.
- Seal waste containers tightly to reduce evaporation, spillage and contamination with water, dirt
or other materials.

- Dispose the scrap, waste and recyclable materials in accordance with Environmental Norms.
- Never dispose of any waste into sanitary sewers.
- Arrange for the safe collection and removal of combustible waste often.
- Lock used oil containers and coolants and secure them from unwanted waste.
- Pack and label coolant and other materials that damage to the environment
- Safely deposit to the hazardous waste disposal site.

**Preventive Measures**

1. **Safety Guards.** By providing proper safeguards to the machines, accidents can be prevented. Some guards are built into a permanent casing, while some are attached afterwards.
2. **Fencing:** Machines or their parts should be fenced when it is not possible to provide safeguards.
3. **Hoists, Cranes and Lifts** etc. must be of sound constructions. They must be tested periodically.
4. **Physical Conditions:** Sufficient illumination and ventilation should be provided. Floor should be free from oiliness. Floor should be kept clean.
5. Utilise appropriate clothing such as apron, gloves and goggles. Remember that loose clothing may be a source of danger.
6. Repair work on machines should **not be done when it is running.**
7. All the tools should be **kept at their proper places.**
8. Chips should **not be removed by hand.**
9. Wear **PPE.**
10. Ensure safe disposal of waste as per environmental norms.

**Ask**

- You can ask about safe working practices.
- You can ask about different waste disposal methods.
- You could ask about preventive measures taken to avoid hazards.
**Activity**

- Conduct a skill practice activity.
- Ask the students to assemble together.
- Explain the purpose and duration of the activity.
- Set guidelines pertaining to discipline and expected tasks.
- Divide the class into five groups.
- Tell them ever group has to do a role play activity. They have to demonstrate a hazard happen in workshop. Then what preventive measures they have to follow and have to explain what are other safety aspects are associated with that hazard.
- Other groups can ask questions to presenting group at the end of role play.
- Give feedback at the end of activity.

**Notes for Facilitation**

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
UNIT 3.3: Fire Safety

Unit Objectives

At the end of this unit, You will be able to:

1. Identify the causes of fire at the shop floor;
2. List the dos and don’ts to prevent fire;
3. Explain how to deal with a fire accident;
4. Describe the different safety precautions at workplace.

Resources to be Used

• Available objects such as a duster, pen, notebook, fire extinguisher and fire safety equipments etc.

Do

• Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

• Fire is defined as a self-sustaining combustion process in which a substance (fuel) combines with oxygen in air to produce immense heat and light.

• Spatter, arc rays and sparks can cause fire during welding if they fall on combustible materials like petrol, wood, acetylene, hydrogen or oxygen cylinders and electrical fittings.

• In case a fire breaks out
  o  use a fire extinguisher
  o  If fire is big, call fire brigade

• Electrical fires are different from regular fires. They cannot be extinguished with water. To put out an electrical fire, the right type of fire extinguisher must be used.

• A fire extinguisher, or extinguisher, is an active fire protection device used to extinguish or control small fires, often in emergency situations.
• Types of fire extinguisher relevant to welding shop are sand, water, foam, dry chemical powder (DCP) and CO$_2$.

• One of the essential responsibilities of an individual is reporting hazards.

• Every worker should be aware of:
  o the people responsible for health and safety at the work place;
  o the name, designation and location of the person responsible to contact at the time of emergency;
  o the names and location of the documents that refer to health and safety.

• Efforts should be taken to reduce the scale & probability of hazards. Effective action is required during emergency situation. For dealing emergencies, effective action is possible due to pre-planned and practiced procedure for dealing such emergencies.

• Mock Drills is a situation in which fake emergency is announced and workmen are asked to follow emergency evacuation plan. This allows the workman to familiarize with the emergency situation and act according to plan.

Safety Precautions

In case a fire breaks out, then

• If it is a small fire use a fire extinguisher.
• If the fire is big, call the fire brigade.
• All those on the shop floor should move towards the exit.

Electric Shock

• Make sure the machine is properly grounded.
• Never permit “live” parts of the electric welding machine to touch bare skin or wet clothing.
• Do not cool electrode holders by putting them in water.
• Turn off power supply when the welding machine is not in use.
• Avoid standing on damp areas while welding.
• Wear leather gloves.
• Ensure that the cables are protected and in great condition.
• Ensure that electrode holders are correctly insulated.
Burns

- Guard your eyes and face from flying particles of slag by using safety glasses or face shield.
- Always wear leather gloves.
- Wear high top shoes.
- Button collar, shirt pockets, etc.
- Avoid touching the electrode or metal where welding has taken place.
- Hold hot metal with pliers or tongs.
- Keep electrode stubs appropriately arranged off.

Radiant Energy

- Protect your head and eyes with a welding helmet and the right shade lens.
- Avoid leaving bare skin exposed to the rays of the arc, wear suitable clothing.
- Never strike the arc without protecting the face and eyes.
- Never look directly at the arc where others are welding without suitable eye protection.

Gases & Fumes

- Work only in well-ventilated areas.
- Be extra careful when working on metals covered with lead or zinc.
- Use respirator or other approved breathing devices if operating in a restricted area.

Combustible Materials

- Keep shop clean in areas where welding is to be done.
- Never weld near inflammable materials of any kind.
- Never weld on shielded containers which may have held inflammable materials without first taking appropriate safety precautions.

Fire Protection

- Get acquainted with location and types of fire extinguishers.
- Report any risky conditions that may begin a fire.
- Never weld near combustible materials.
- Never weld near electrical fittings or lines.

Trips & Falls

- Keep work areas clear of equipment, machines, cables and hoses.
- Always properly maintain and use handrails.
- Always use and maintain safety lines, harnesses and lanyards.
Classes of type of fire extinguisher

1. Water (Class A)
   - Suitable for Class “A” fires only.
   - To allow visual capacity check, there is a pressure gauge.
   - 30-40 ft. maximum effective range.
   - Can be started and stopped as necessary.
   - Extinguishes by cooling burning material below the ignition point.

2. Carbon Dioxide CO₂ (Class B, C)
   - Suitable for Class “B” or “C” fires.
   - 2.5-100 lb. of CO₂ (8-30 seconds discharge time).
   - Has NO pressure gauge—capacity verified by weight.
   - 3-8 ft. maximum effective range.
   - Extinguishes by smothering burning materials.
   - Effectiveness decreases as temperature of burning material increases.

CO₂ extinguishers are specially designed to put out electrical fires. They have a wide nozzle that expels the CO₂ gas.

3. Dry Chemical or Powder (Class A,B,C)
   - Suitable for Class “A”, “B”, and “C” fires.
   - 2.5-20 lb. dry chemical (ammonium phosphate).
   - 8-25 seconds discharge time.
   - To allow visual capacity check, it has pressure gauge.

Dry chemical extinguishers are also designed to put out electrical fires. These extinguishers are better than CO₂ extinguishers as they prevent fires from reigniting.

Safety Signages

It is important to know the meaning of safety signs. Such signs warn us of danger and allow us to take precautions to keep safe. There are four main types of safety signs:

- Prohibition signs
- Mandatory signs
- Warning signs
- Information signs
### Table 3.3.1: Safety Signages

<table>
<thead>
<tr>
<th>Smoking and Naked Flames Prohibited</th>
<th>Do Not Extinguish with Water</th>
<th>Wear Head Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wear Eye Protection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wear Foot Protection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wear Hand Protection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk of Fire</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk of Electric Shock</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk of Explosion</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Table 3.3.1: Safety Signages*
Steps for using the fire extinguisher

**STEP 1:** Pull the Pin at the top of the extinguisher. The pin releases a locking mechanism and will allow you to discharge the extinguisher.

**STEP 2:** Aim at the base of the fire, not the flames. This is important - in order to put out the fire, you must extinguish the fuel.

**STEP 3:** Squeeze the lever slowly. This will release the extinguishing agent in the extinguisher. If the handle is released, the discharge will stop.

**STEP 4:** Sweep from side to side. Using a sweeping motion, move the fire extinguisher back and forth until the fire is completely out.

---

Procedure for Reporting and Responding to Accidents and other Emergencies

**STEP 1:** Gathering Facts: Collect and note all the facts, including –

- Date, time, and location of accident
- Names, job titles, workers and immediate supervisor involved
- Events leading up to the accident
- Job that a worker was handling at the time of the accident
- Names of workers/supervisor who witnessed the accident
- Surrounding conditions (e.g. greasy floor, insufficient lighting, noise, etc.)
- Circumstances at the time of accident (including tasks, equipment, tools, materials, etc.)
- PPE worn by the worker at the time of the accident
- Injuries that occurred (name of the injured body part and characteristics and extent of injuries)
- Type of treatment for injuries (first aid if given)
- Damage to equipment, materials, and the worker was working on or any other equipment or material around it.
STEP 2: **Determining the Sequence:** Describe this sequence in events after gathering the facts — 
- **Events leading up to the accident:** Task the worker was performing at the time of accident. For example: bending over, climbing, lifting operating machinery, etc.
- **Events involved in the accident:** Was the employee struck/caught in the machine or caught in the fire? Did the worker fall on the same level or from a height?
- **Events immediately following the accident:** What did the employee do: started bleeding? Body caught fire? Complain about back pain? Put Response from other workers/supervisor. Did they call for help, administer first aid, shut down equipment etc.?

STEP 3: **Analysing:** Analyse of the causes of the accident.

- Primary cause (e.g., a slip and fall from a ladder)
- Secondary causes (e.g., employee not wearing appropriate goggles or helmet)
- Other contributing factors (e.g., poor ventilation).

STEP 4: **Recommending:** Recommendations for corrective action

- Training on safe work practices
- Preventive maintenance exercises that keep equipment in great working condition
- Assessment of job techniques with a proposal for changes
- Conducting a job hazard analysis to evaluate the task for any other hazards
- Engineering changes that make the task safer or administrative changes that might include changing the way the task is performed.

**Tips**

**How to Prevent Fire**

<table>
<thead>
<tr>
<th>Dos</th>
<th>Don’ts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keep welding area clean.</td>
<td>Do not wear inflammable materials like nylon etc.</td>
</tr>
<tr>
<td>If empty containers contain flammable materials, fill them with water.</td>
<td>Never weld near electrical lines.</td>
</tr>
<tr>
<td>Report any unsafe situation that may cause a fire.</td>
<td>Never weld near combustible materials.</td>
</tr>
<tr>
<td>Watch where the sparks and metals are falling from your work.</td>
<td>Never leave any cable without insulation.</td>
</tr>
</tbody>
</table>
At the time of emergency evacuation one must:

- Raise the alert by crushing the glass cover of the closest break-glass alarm unit.
- Be calm and composed. Switch off all electrical apparatus except lights.
- If possible, shut doors around the fire area to stop it from spreading.
- Leave the Building/site area immediately. Follow the evacuation queue.
- Give first preference to the physically handicapped, expectant mothers and the elderly
- If it’s dark and smoky, get down on your hands and knees and crawl to the nearest exit by counting the number of door.
- Be acquainted with the hot exit door and pay attention for the thick smoke in the staircase. In the event that the staircase is free from smoke, follow the directional signs and handrails.
- Gather at the designated assembly point.
- Do not re-enter the building until the signal is given
- Max. time for evacuation - 2.5 to 3.0 minutes.

Ask

- You could ask the common fire extinguisher.
- You could ask the type of fire extinguisher and their role?
- You could ask what all information contains fire drill report.

Activity

- Conduct a skill practice activity.
- Ask the students to assemble together.
- Explain the purpose and duration of the activity.
- Set guidelines pertaining to discipline and expected tasks.

<table>
<thead>
<tr>
<th>Skill Practice</th>
<th>Time</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of fire extinguisher</td>
<td>1 hour</td>
<td>Fire extinguisher</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PPE</td>
</tr>
</tbody>
</table>
Do

- Ask them to get into pairs for practice.
- Go around and make sure they are doing it properly.
- Wrap the unit up after summarizing the key points and answering questions.

Field Visit

You could visit any of the industry and show the firefighting equipment. With the help of field visit you could show the where we need to fit various firefighting equipment and its role.

Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
UNIT 3.4: First Aid for Electric Shock and Burns

Unit Objectives

At the end of this unit, You will be able to:
1. Describe how to give first aid in case of burns and shocks.

Resources to be Used

- Available objects such as a duster, pen, notebook, first aid box etc.

Do

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

- Burns are caused by coming in contact with hot objects accidentally. Burns can be minor or major.
- You can get an electric shock if current passes through your body or hair. When a person gets a severe shock his or her skin turns white or pale blue. The first aid has to be given to the victim.

Demonstrate

First aid steps

For Minor Burns

**STEP 1:** Pour cold water on the burnt area.
**STEP 2:** Apply a paste of baking soda and water or use a wet compress of baking soda solution in water.
**STEP 1:** Cover the burnt area with a thin cloth to keep it free of dust.

For Major Burns

**STEP 1:** In case a person's clothes are on fire drop him to the ground and roll him over until the fire is put out.
**Activity**

- Conduct a skill practice activity.
- Ask the students to assemble together.
- Explain the purpose and duration of the activity.
- Set guidelines pertaining to discipline and expected tasks.

<table>
<thead>
<tr>
<th>Skill Practice</th>
<th>Time</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>First aid practices</td>
<td>3 hours</td>
<td>Mannequin</td>
</tr>
<tr>
<td></td>
<td></td>
<td>First aid box</td>
</tr>
</tbody>
</table>

**Do**

- Ask them to get into pairs for practice.
- Go around and make sure they are doing it properly.
- Wrap the unit up after summarizing the key points and answering questions.
Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
UNIT 3.5: 5S

Unit Objectives

At the end of this unit, students will be able to:

1. Explain importance of 5S;
2. Describe 5S activities.

Resources to be Used

- Available objects such as white Board, white board marker pens, duster, participant manual etc.
- PC with LCD Projector or Flip Chart

Do

- Greet and welcome the participants to the next session of the program.
- Before starting the session ask them do they have any doubts pertaining to the previous unit.

Say

- 5S is designed as a visually-oriented system of cleanliness, organization and arrangement.

Elaborate

5S Approach: 5S is created by a list of five Japanese words: seiri, seiton, seiso, seiketsu, and shitsuke. 5S system is implemented for organizing the workplace for increasing effectiveness and efficiency by maintaining the area and items, storing the items used, and sustaining the new practices.

Benefits of 5S are:

- Cleaner and safety work
- Reduced waste of time through more workplace organization
- Organised space
- Improved self-discipline
- Improved workplace culture

**5S consist of:**

- **Sorting** - Sorting and separating tools removes unnecessary items from the work area and keep the place clean.
- **Simplifying** - Tools kept at the appropriate storage area are clean and ready to use.
- **Systematic Cleaning** - Organized daily cleaning and inspection of the workplace.
- **Standardizing** - Standardizing makes unusual and out-of-the-ordinary conditions noticeable.
- **Sustaining** - It is aimed to maintain the improvements from the other 5S activities.

**Phases of 5S:**

<table>
<thead>
<tr>
<th>Japanese term</th>
<th>English Term</th>
<th>Meaning in Japanese Context</th>
</tr>
</thead>
</table>
| Seiri         | Sort         | • Dispose off unnecessary items or properly remove.  
• Do work simply by removing obstructions.  
• Stop buildup of needless things.  
• Calculate necessary items for costing and other factors.  
• Remove all parts not in use.  
• Separate unwanted items from the workplace.  
• Define a red-tagged area to keep unnecessary items.  
• Waste removal. |
| Seiton        | Set          | • For items to be easily available arrange them all properly  
• By arranging work station in such a way that all tooling / equipment is in close proximity  
• Work on first come and first serve basis method  
• All work should be complete on regular basis |
| Seiso         | Shine        | • Workplace should be completely clean and clear  
• Stop weakening of machinery and equipment  
• Keep workplace safe and clean |
| Seiketsu      | Standardize  | • Regulate the best practices in the work area.  
• Keep high standards at workplace organization at all times.  
• Keep everything in order and according to its standard.  
• Everything in its right place. |
<table>
<thead>
<tr>
<th>Shitsuke</th>
<th>Sustain</th>
</tr>
</thead>
<tbody>
<tr>
<td>• To maintain in working order</td>
<td></td>
</tr>
<tr>
<td>• Also translates as “do without being told”</td>
<td></td>
</tr>
<tr>
<td>• Regular audits to be perform</td>
<td></td>
</tr>
<tr>
<td>• Discipline and Training</td>
<td></td>
</tr>
</tbody>
</table>

### Measuring the 5S Level of Achievement:
Check the level of 5S from I to V for Simplifying.

### Table 3.5.1: 5S Levels of Achievement

<table>
<thead>
<tr>
<th>Level V: Continuously Improve</th>
<th>Level IV: Focus on Reliability</th>
<th>Level III: Make It Visual</th>
<th>Level II: Focus on Basics</th>
<th>Level I: Just Beginning</th>
<th>Place yellow box where each area is on the 5S levels of Achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleanliness problems are identified and mess prevention actions are in place.</td>
<td>Work area has recorded housekeeping tasks and agendas and the jobs are consistently followed.</td>
<td>Preliminary cleaning has been completed and clutter is recognized and improved.</td>
<td>Essential and non-essential items are identified. Those non-essential items are withdrawn from work area.</td>
<td>Essential and non-essential items are mixed throughout the work area.</td>
<td>Sorting</td>
</tr>
<tr>
<td>Needed items can be recovered within 30 seconds and need a less number of steps.</td>
<td>Needed items in work area are minimized in number and are well organized for recovery and use.</td>
<td>Needed items are outlined, dedicated locations are properly labeled and required quantities are determined.</td>
<td>Essential items are carefully stored and organized as per occurrence of use.</td>
<td>Items are located arbitrarily all over the workplace.</td>
<td>Sorting</td>
</tr>
<tr>
<td>Possible problems are recognized and counter measures are recorded.</td>
<td>Inspection occurs during daily cleaning of work areas and equipment and supplies.</td>
<td>Visual controls and identifies are established and marked for the work area, equipment files and supplies.</td>
<td>Important work area items to be checked are recognized and adequate performance levels recorded.</td>
<td>Important work area items checked are not recognized and are not marked.</td>
<td>Sorting</td>
</tr>
<tr>
<td>Well-grounded approaches and standards for housekeeping, routine supervisions and workspace arrangement are shared and are used throughout similar work areas.</td>
<td>Dependable procedures and standards for housekeeping, routine supervisions and workplace plan are recorded and abided by all members of the work group.</td>
<td>Work Group has recorded arrangements on visual controls tagging of items and desired amounts of necessary items.</td>
<td>Work group has recorded arrangements for essential items, organization and work area controls.</td>
<td>Work area checks are haphazardly executed and there is no visual measurement of 5S.</td>
<td>Sorting</td>
</tr>
</tbody>
</table>

Sources and recurrence of issues are recorded as a component of routine work. Root causes are identified and corrective action plans are developed.
• Summarize the main points.
• Ask participants if they have any doubts.
• Encourage them to ask questions.
• Answer their queries satisfactorily.
• Tell participants to complete the questions at the end of the unit.
• Ensure that every participant answer all the questions.

**Ask**

- You could ask the objectives and advantages of 5S
- You could ask the 5 levels of checking 5S

**Activity**

- Conduct a skill practice activity.
- Ask the students to assemble together.
- Do the 5S audit of your training center and check the level of center

**Field Visit**

You could visit any of the industry and show the firefighting equipment. With the help of field visit you could show the where we need to fit various firefighting equipment and its role.

**Notes for Facilitation**
4. Conventional Turning

Unit 4.1 – Basic Parts and Working Principle
Unit 4.2 – Cutting Tool Angles – Single Point Cutting
Unit 4.3 – Outer Diameter (OD) Turning
Unit 4.4 – Facing
Unit 4.5 – Turning Between Centers
Unit 4.6 – Taper Turning
Unit 4.7 – Drilling
Unit 4.8 – Boring
Unit 4.9 – External Grooving
Unit 4.10 – Internal Grooving
Unit 4.11 – Fundamentals of Thread Cutting In Lathe
Unit 4.12 – External Threading
Unit 4.13 – Internal Thread Cutting
At the end of this module, students will be able to:

1. Identify the parts of the conventional lathe machine;
2. Explain the working principle of a conventional lathe machine;
3. Explain about the types of cutting tools;
4. Explain the angles of various lathe cutting tool;
5. List the cutting tools;
6. Identify the inputs needed with reference to the outer diameter turning;
7. Perform the operation;
8. Identify the tools with reference to the facing operation;
9. Perform the operation;
10. Perform turning between centers;
11. Perform the operation of taper turning;
12. Perform drilling operation;
13. Perform drilling operation;
14. Perform the boring operation;
15. Identify the tools with reference to the External grooving operation;
16. Perform the operation;
17. Identify the tools with reference to the Internal grooving operation;
18. Perform the operation;
19. State the elements of thread cutting;
20. Identify the tools with reference to the External Threading operation;
21. Perform the External Threading operation;
22. Identify the tools with reference to the internal threading operation;
23. Perform the internal threading operation;
24. Identify the tools with reference to the Parting operation;
25. Perform the Parting operation.
UNIT 4.1: Basic Parts and Working Principle

Unit Objectives

At the end of this unit, you will be able to:

1. Identify the parts of the conventional lathe machine;
2. Explain the working principle of a conventional lathe machine.

Resources to be Used

- Available objects such as white board, white board marker pens, duster, Participant manual.
- PC with LCD Projector or Flip chart
- Lathe machine, workpiece

Do

- Greet and welcome the participants to the next unit of the program.

Say

- In this session we learn about lathe machine and its parts.
- Lathe machine is one of the oldest machines used to cut wood or metal. The traditional lathe machine uses a rope that is wound round the work.
- The function of the lathe machine is to cut a metal or wooden block into a desired shape and size.
- The block, also called the work piece is held securely and rigidly on the machine, rotated against the cutting tool. The cutting tool removes the extra metal uniformly from the clock and gives the block a desired shape.
- To cut the material properly the tool should be harder than the material of the work piece, should be rigidly held on the machine and should be fed or progressed in a definite way related to the work.
- A lathe machine has different parts and all parts have different function.
Function of a Lathe Machine

1. **Height of Centre**: The height of the centers measured over the lath bed.
2. **Swing over Bed**: Swing or max diameter that can be rotated over the bed ways.
3. **Swing or Diameter over Carriage**: This concerns the biggest diameter over carriage of work that will orbit over the lathe saddle.
4. **Distance between Centres**: Max job length in mm that may be held between the centers (head stock & tail stock).
5. **Bed Length**: This indicates the approx. floor space occupied by the lathe.

Functions of Different Parts of a Lathe Machine

1. **Bed**: The base of the machine is the lathe bed. At either end of the bed, one will find the headstock and the tailstock while the carriage rests over the lathe bed and slides on it.

   **The functions of a lathe bed are**:
   - To locate the fixed units in accurate relationship to each other.
   - To provide slides upon which the operating units can be moved.

2. **Headstock**: The headstock is positioned on the left hand end of the lathe bed. The headstock provides mechanical means of rotating the work piece at multiple speeds.

   **Its main functions are**:
   - Provide a means to assemble work-holding devices.
   - Transmit the drive from the main motor to the work to make it revolve.
   - Accommodate shafts with fixed and sliding gears for providing a wide range of work speeds.
   - Have shift leavers to slide gears to bring in mesh for different speeds.
   - Have a means for lubricating the gears, shafts and bearings.

3. **Tailstock**: The tailstock is located at the right-hand side of the bed, on the inner ways.

   **Functions of tailstock**:
   - When being machined between centres, it supports the other end of the work.
   - It holds a tool for performing operations such as drilling, reaming, tapping, etc.
   - To turn the external taper by offsetting the body of the tailstock with respect to the base.
   - To perform external operation of the shaft held between centers.

4. **Carriage**: The carriage is the part of the lathe which slides over the bed-ways between the headstock and the tailstock. It provides various movements for the cutting tool manually as well as by power feed.
The carriage consists of following parts:

a. **Saddle**: It is a casting that fits over the bed and slides along the ways. It carries the cross slides and tool post.

b. **Cross slide**: The cross slide comprises a casting, machined on the underside for attachment to the saddle and carries the tool post or compound rest. In order to move the cross slide, the feed screw is turned by rotating the hand-wheel.

c. **Compound Rest**: The compound rest or compound slide is placed on top of the cross slide and has a circular base with measurement in degrees. It is used to ensure angular cuts and short tapers and it also ensures convenient positioning for work.

d. **Tool Post**: This is located on the top of the compound rest to hold the tool and to enable it to be adjusted to a convenient working position. The type and mounting of the tool post depends upon the class of work for which it is to be used.

---

**Demonstrate**

**Standard operating procedure on CNC lathe machine**

**Starting Procedure:**

1. Wear the safety equipments
2. Before starting the machine, follow the preventative maintenance checklist and update
3. Switch on the main and main control panel
4. Switch on the stabilizer
5. Ensure that all the 3 LED green buttons shall be in “display mode”.
6. Switch on the CNC “ON green button” on CNC control panel
7. Wait until the system boot
8. Release all the emergency push buttons
9. Switch on the jog mode, speed on, feed on buttons
10. Ensure that air pressure should reach above 6bar and lubrication oil level
11. Switch on the MAG. Reference button
12. Make sure that coolant level is ok

**General Operation:**

1. Check for the availability of necessary documents (Electrodes data after CNC lathe), tools, measuring equipments, before starting the work
2. Before starting the job, program sheet shall be verified
Environmental Instructions:
1. Dispose the tool chips, cotton waste in the designed bin
2. Keep the aisle clean and clear

Health & Safety Instructions:
• Wash the hands after dispose
• Keep away from electrical connections and use the emergency controller
• Do not keep hands in the rotating cutters
• Do not open the door while machine is in running condition
• Use eye wash fountain, if any particles or dust falls on eyes.

Tips

3. Select the appropriate cutters as per program sheet
4. Make the work offset as per the defined program sheet
5. Make the tool offset as per the defined program sheet
6. Ensure that the required program has come to the machine or not
7. Ensure that there are no damages on EROVA holder before clamping into the machine.
8. Ensure program selection is correct or not (select the appropriate program and check for the parameters and run the program.
9. Inspect the job as per the drawing or model and update the record in drawing sheet
10. If new tool is manufactured then inspect the tool as per drawing and register report.

Shutdown Procedure:
1. Switch on the jog mode
2. Move all axis to middle
3. Press the emergency push buttons and switch off the stabilizer, mains.
Activity

- Conduct a skill practice activity.
- Ask the students to assemble together.
- Explain the purpose and duration of the activity.
- Set guidelines pertaining to discipline and expected tasks.

<table>
<thead>
<tr>
<th>Skill Practice</th>
<th>Time</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perform standard operating procedure on lathe</td>
<td>4 hour</td>
<td>Lather machine, workpiece and cutting tool</td>
</tr>
</tbody>
</table>

Do

- Divide the class into groups.
- Go around and make sure they are doing it properly.

Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
At the end of this unit, you will be able to:

1. Explain about the types of cutting tools;
2. Explain the angles of various lathe cutting tool;
3. List the cutting tools.

UNIT 4.2: Cutting Tool Angles – Single Point Cutting

Unit Objectives

Resources to be Used

- Available objects such as white board, white board marker pens, duster, Participant manual.
- PC with LCD Projector or Flip chart
- Cutting tools

Do

- Greet and welcome the participants to the next unit of the program.

Say

- In this session we learn about cutting tools.
- On lathe machine, cutting is done with the help of cutting tools or cutters. They use shear deformation to discard material from the work piece.
- Cutting is done by either single point or multi point tools. Single point tools are used when we need to do turning, shaping, and remove material by means of one cutting edge. Multipoint tools are required in case of lathe and drilling. The grinding tools are multipoint tools.
- Single point cutting tools are of following types: solid tools, HSS tools, tip tools and throw away tools.
- Cutting tools are made up of the following:
  - **High Carbon Steel**: It contains carbon from about 0.75 to 1.25%. It is useful for marking light finishing cuts and for machining soft materials.
  - **High Speed Steel**: Also known as HSS, it contains very little carbon. It contains alloying elements like chromium, manganese, molybdenum, tungsten and cobalt. It is tough enough to withstand
shocks during cutting and retains hardness at higher speeds than carbon steel.

- **Cemented Carbide Tip:** Carbide is the hardest cutting material available. They are very brittle too. Majorly used as throw away type tool bit.

- Accurate cutting is possible only if the tool is used in a proper angle. To cut metal parts, it becomes essential to use proper angle of cutting.

- Cutting angles are of 4 types: Clearance angle, wedge angle, rake angle, cutting edge angle.

- Harder materials are provided with smaller clearance angle and smaller rake angle.

- The cutting force and power requirement changes due to change in cutting tool geometry.

- Application of coolant aids in reducing the cutting force required for machining while using a cutting tool with specific geometry.

---

**Properties of Cutting Tool Material**

- **Hardness:** Only when the tool is harder than the material it has to cut, it can cut/shear the other material.

- **Hot Hardness:** The cutting tool material should retain its original hardness at higher temperatures.

- **Toughness:** If the tool is not tough, it would break when the cutting loads and jerks acts on it.

- **Wear Resistance:** If the material is not wear resistant, it would wear out fast without giving much life to the tool cutting edge.

- **Low Coefficient of Friction:** The coefficient of friction at the chip-tool interface should be as low as possible, which is achieved by the way of right tool angles, proper cutting speed and use of proper coolant.

- **Cost:** The cost of cutting tool material should be within reasonable limits.

- **Ease of Manufacture:** The raw material for the cutting tool should be easily available and it should be easy to manufacture the tools.

**Tool Angles**

The 4 basic angles used on a cutting tool:

1. **Clearance angle (α)** –
   - Angle between machined surface on the work piece and the trailing edge of work piece.

---

**Fig. 4.2.1: Clearance Angle**
• This is provided for avoiding friction (rubbing) arising due to contact between work piece and cutting tool.
• Clearance angle is selected based on the work piece material.
• **The types of clearance angles:** Front Clearance Angle and Side Clearance Angle

2. **Wedge angle (β)**
• Is the angle between rake surface and clearance surface?
• Wedge angle imparts strength to the cutting tool.

3. **Rake angle (ϓ)**
• Angle between plane perpendicular to machined surface on the work piece and the surface on which chip flows.
• Rake angle is provided for easy penetration of cutting tool into the work piece and remove material in the form of chip.
• The ability of the tool to form the chip by shearing the work material is dependent on the back rake angle. This angle can be negative or positive. To gain smaller deflections of the work piece, tool holder, and machine, the use of positive rake angles is employed. The capacity of the tool to conduct heat and the strength of the tool sees reduction if the back rake angle is too big. The back rake angle should reduce when the hardness increases. The back rake angle is generally positive for high-speed steels.
• **Front rake angle:** The front rake influences the machining condition when the tool removes metal from its cutting edge.
• **Side rake angle:** The side rake influences the machining condition when it removes metal on its side cutting edge only. A knife edge turning tool may not have any front rake but must have a definite amount of side rake.

4. **Cutting Edge Angle**
• **Side Cutting Edge Angle:** The side cutting edge angle of turning tools vary from 0º to 90º. The following are the advantages of increasing side cutting edge angle.
  o It increases tool life as, for the same depth of cut the cutting force is distributed on a wider surface.
  o It diminishes chip thickness for the same amount of feed and permits greater cutting speed.
  o It dissipates heat quickly for having wider cutting edge.
  o It improves surface finish.

![Fig. 4.2.2: End Cutting Edge Angle](image)
- **End Cutting Edge Angle**: The main function of the end cutting edge angle is to prevent the trailing front cutting edge of the tool from rubbing against the work. The end cutting edge angle ranges from 8 to 15 degree. A large end cutting edge unnecessarily weakens the tool.

**Nose Radius**: All turning tools have a slightly rounded nose.

**The functions of nose radius are as follows:**

- Surface finish is improved when using tools with a greater nose radius as they can clear up feed marks caused by shearing action. All finish turning tools have greater nose radius than rough turning tools.
- It increases the strength of the cutting edge, tends to minimize wear taking place in sharp pointed tool with consequent increase in tool life.
- Accumulation of heat is less than that in a pointed tool which permits higher cutting speeds.
- Slight reduction in cutting force may be obtained.

Very large nose radius may cause chatter. For rough turning, nose radius is usually 0.4mm and for finish turning it varies from 0.8 to 1.6mm.

**Selection of Angles**

The tool angles vary under different machining conditions. The following table gives the recommended angles as per the material used.

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild Steel</td>
<td>10 - 12</td>
<td>6 - 8</td>
<td>10 - 12</td>
<td>6 - 8</td>
</tr>
<tr>
<td>Stainless Steel</td>
<td>5 - 7</td>
<td>6 - 8</td>
<td>8 - 10</td>
<td>7 - 9</td>
</tr>
<tr>
<td>Aluminium</td>
<td>30 - 35</td>
<td>8 - 10</td>
<td>14 - 16</td>
<td>12 - 14</td>
</tr>
<tr>
<td>Brass</td>
<td>0 - 6</td>
<td>8 - 10</td>
<td>1 - 5</td>
<td>10 - 12</td>
</tr>
<tr>
<td>Cast Iron</td>
<td>3 - 5</td>
<td>6 - 8</td>
<td>10 - 12</td>
<td>6 - 9</td>
</tr>
<tr>
<td>Copper</td>
<td>14 - 16</td>
<td>12 - 14</td>
<td>18 - 20</td>
<td>12 - 14</td>
</tr>
</tbody>
</table>

**Do**

- Show available cutting tools to the class.
- Show different cutting angles to the trainees on cutting tool.
Ask

- Ask about function of cutting tools.
- Ask about importance of proper selection of cutting tools.
- Ask about different properties required for selection of a cutting tool.

Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
In this session we learn about turning operation.

Turning as a machining process where a cutting tool follows a helical path by moving straight while the work piece revolves.

The tool's axes of movement are essentially linear though it may be along a straight line or along some set of curves or angles. When this cutting action is applied to external surfaces, it is referred to as “turning”, while the term “boring” is used to refer to the same cutting action applied on internal surfaces.

Work setting is essential to do the truing of the job in the independent chuck. If turning is not done the following will be the results:

1. Uneven load on the cutting tool
2. For the same depth more metal will be removed from the out of centre portion
3. Surface turned may not be cylindrical.

Like work setting, proper tool setting is also important.
• Turning is undertaken with a lathe and can be of numerous types such as straight turning, taper turning, profiling, facing, drilling, boring, thread cutting (both internal and external), grooving (both internal and external) etc. These turning processes can produce different shapes such as straight, conical, curved or grooved work piece.

• Usually, turning utilises simple single-point cutting tools.

• Plain turning is done in two stages.
  1. Rough turning
  2. Finish turning

Elaborate

**Tool setting**

A tool must be properly set with reference to the line of the centres. If the tool nose is positioned slightly above the line of centres, the rake angle is increased and the clearance angle is decreased. This also decreases the cutting angle. It has a somewhat favourable effect on the cutting conditions. The chips flow over the tool face with less friction. The chip is coiled into a spiral, hence less deformed and thus the cutting force is reduced.

But on the other hand, the friction between the flank and the work is increased. The cutting edge has a tendency to dig into the work, which may result in chattering, reduced accuracy. A poorer surface finish and in some cases, even breakage of the tool. Important points that one should keep in mind while doing tool setting:

- For turning operations set the nose of the tool slightly above the centre of the work.
- Normally the cutting edge should be set to a maximum of 0.5mm above the centre. If it is set too high, the work will rub against the tool and the cutting action will be inefficient. If the tool is set too much below the centre of the work, it will lead to breakage of the tool and very poor surface of the job.
- The cutting tool should be set in such a manner that it does not extend too far out of the tool holder as this will lead to chattering finish on the job.
- Too much overhang will cause vibrations and may break the tool.

**Tool setting ways:**

- **Setting on centre line**: The correct height of the tool is always required. It is obtained by placing metal sheet packing underneath. The packing must be straight and clean.

![Fig. 4.3.1: Tools](image-url)
• **Setting above the Centre Line:** The rake angle becomes smaller, clearance angle reduces thus more friction is created between clearance face of the tool and cut face of the work piece. Chips separate easily and thicker chips can be removed. For roughing operation the tool is occasionally set above the centre line (up to 2% of the work piece diameter).

• **Setting below the Centre Line:** the rake angle becomes larger and less friction is created between clearance face and cut face becomes smaller and chips are difficult to separate.

**Two stages of turning**

• **Rough turning:** By rough turning we bring the size of the work close to the required size, leaving sufficient metal for finishing. The tool is selected, depending upon the amount of material to be removed. The normal direction of feeding the tool is from the tailstock end to the headstock end. By rough turning we can remove maximum metal in the shortest time. Surface finish and accuracy are not of much importance during rough turning.

  The tool cutting edge should be sharp and ground to the recommended rake and clearance angles. Depending upon the material to be turned and the tool material, the recommended cutting speed is to be chosen from the chart available, to determine the spindle speed for plain turning. The selection of the recommended feed rate is also important which greatly depends upon the depth of cut and the cutting speed chosen.

• **Finish turning:** It is done after rough turning, and it aims to bring the size of the work within the specified accuracy and with better surface finish. The tool to be used in this case will be a finish turning tool which may be a round nose finishing tool with a larger nose radius than normal.

  Finish turning is also carried out from the tailstock end towards the headstock end. Finishing cut as far as possible is to be limited to one or two depending upon the amount material available for removal. The cutting speed chosen should be higher than that chosen for roughing by 1 1/2 to 2 times, whereas the feed rate may, depending upon the surface finish needed, be as low as possible.

---

**Demonstrate**

**Work setting procedure on lathe**

1. Keep the main spindle in a neutral position.
2. Measure the job diameter with an outside calliper.
3. Position the jaws of the independent chuck, equidistant from the centre.
4. The distance between the inner face of the opposite jaws is equal to the diameter of the work.
5. Open the adjacent jaws sufficiently enough to insert the work.
6. Place the work inside the chuck, keeping sufficient portion outside the chuck for turning, and tighten the two adjacent jaws enough to grip the work.

7. Place the dial gauge on the bed-ways close to the chuck.

8. Adjust the pointer to make its tip move close to the top or side portion of the work with a minimum gap.

9. Rotate the chuck by hand and observe if there is any deviation from the dial gauge pointer observe for the reason may be the piece is not properly fitted into the chuck or the job itself is not straight. If there is margin with respect to the diameter to be turned then continue else replace the piece.

10. Engage the spindle levers at about 250 rpm and run the machine.

11. Touch the pointer of dial gauge and see the fluctuation once again.

12. If the fluctuation is not much then it indicates that the work is trued.

13. Finally, tighten the jaws with more pressure.

14. Check once again for the true running of the work.

15. Touch the pointer of dial gauge and see the fluctuation once again.

16. If the fluctuation is not much then it indicates that the work is trued.

17. Finally, tighten the jaws with more pressure.

18. Check once again for the true running of the work.

**Clamping tool on tool post**

1. Clean the tool.

2. Loosen the mounting screw on the tool post using suitable spanner or wrench.

3. Remove old tools if any present.

4. Clean the tool seating surface.

5. Place the tool in the tool post.

6. Clamp the tool by tightening the mounting screws

7. Adjust the centre height of the tool.

This can be done by adjusting the screw in the quick change tool post or by placing shims (small pieces of steel sheets) between the cutting tool and seating surface.

8. Check for approach angle to avoid rubbing of machine surface by the tool.

**Steps for OD Turning**

**Step 1:** Clamp the work piece on the chuck.
Step 2: Turn on the main switch to rotate the spindle and check for trueness.

Step 3: Mount the cutting tool in the tool post and check for the centre height.

Step 4: Select the required spindle speed by changing the belt position in the pulley or by changing the gear shifter lever.

Step 5: Move the slide closer to the starting position of the work piece.

Step 6: Touch the tool on the work piece outside diameter and note the reading on the dial mounted on the hand wheel of cross slide.

Step 7: Pull out the tool away from work piece by moving the cross slide.

Step 8: Move the longitudinal slide to right side to a convenient position for start turning.

Step 9: Adjust the cross slide by adding needed depth of cut.

Step 10: Switch ON the spindle.

Step 11: Move the longitudinal slide to the left side for turning the work piece by rotating hand wheel, up to the required length.

Step 12: After reaching the required length pull out the tool away from the work piece by moving the cross slide by rotating the hand wheel.

Step 13: Move the apron to right side to a convenient position by rotating the hand wheel.

Step 14: Stop the spindle and measure the machined outside diameter using micrometer or vernier calliper.

Step 15: Compare present machined outside diameter and the drawing dimension for deciding further steps of cut.

Step 16: Repeat step 11 to 15 till correct dimensions are achieved.

Activity

- Conduct a skill practice activity.
- Ask the students to assemble together.
- Explain the purpose and duration of the activity.
- Set guidelines pertaining to discipline and expected tasks.

<table>
<thead>
<tr>
<th>Skill Practice</th>
<th>Time</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>OD turning operation on given workpiece</td>
<td>4 hour</td>
<td>CNC Lather machine, workpiece and turning tool</td>
</tr>
</tbody>
</table>
Do

- Divide the class into groups.
- Go around and make sure they are doing it properly.

Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
At the end of this unit, you will be able to:

1. Identify the tools with reference to the facing operation;
2. Perform the operation.

Unit Objectives

Resources to be Used

• Available objects such as white board, white board marker pens, duster, Participant manual.
• PC with LCD Projector or Flip chart
• CNC Lathe machine, workpiece, facing tool

Do

• Greet and welcome the participants to the next unit of the program.

Say

• In this session we learn about facing operation.
• For creating a flat surface, we need to perform the facing operation.
• The facing operations are undertaken with the help of facing tool. Be aware that the work piece is most of the time cylindrical and the use of a chuck is required to form cubes and non-cylindrical shapes.
• The work piece should be placed within 2-3 times its diameter from the chuck jaws unless the free end is supported by a steady rest.
• Like in OD diameter you need to do the truing job similarly in facing too you have to do the same. It’s important to do truing in the independent chuck before doing any operation. In case truing is not done, it will lead to following results:
  1. Uneven load on the cutting tool.
  2. For the same depth more metal will be removed from the out of centre portion.
  3. Surface turned may not be cylindrical.
• Tool setting would be same in facing like it was in Outer Diameter.
• Select a cutting tool with a slightly rounded tip.
• To get a smooth surface, avoid a sharp, pointed tool.
• The tip of the cutting tool must come at a slight angle on to the work piece. Additionally, the cutting tool should be clamped to the tool post. The angle that must be maintained during facing will be between 30° to 60°.
• Sometimes faced work has some defects. It is important to find defects on faced work.

---

**Demonstrate**

**Work setting procedure on lathe**

1. Keep the main spindle in a neutral position.
2. Measure the job diameter with an outside calliper.
3. Position the jaws of the independent chuck, equidistant from the centre.
4. The distance between the inner face of the opposite jaws is equal to the diameter of the work.
5. Open the adjacent jaws sufficiently enough to insert the work.
6. Place the work inside the chuck, keeping sufficient portion outside the chuck for turning, and tighten the two adjacent jaws enough to grip the work.
7. Place the dial gauge on the bed-ways close to the chuck.
8. Adjust the pointer to make its tip move close to the top or side portion of the work with a minimum gap.
9. Rotate the chuck by hand and observe if there is any deviation from the dial gauge pointer observe for the reason may be the piece is not properly fitted into the chuck or the job itself is not straight. If there is margin with respect to the diameter to be turned then continue else replace the piece.
10. Engage the spindle levers at about 250 rpm and run the machine.
11. Touch the pointer of dial gauge and see the fluctuation once again.
12. If the fluctuation is not much then it indicates that the work is trued.
13. Finally, tighten the jaws with more pressure.
14. Check once again for the true running of the work.

**Clamping tool on tool post**

1. Clean the tool.
2. Loosen the mounting screw on the tool post using suitable spanner or wrench.
3. Remove old tools if any present.
4. Clean the tool seating surface.
5. Place the tool in the tool post.
6. Clamp the tool by tightening the mounting screws
7. Adjust the centre height of the tool.
   This can be done by adjusting the screw in the quick change tool post or by placing shims (small pieces of steel sheets) between the cutting tool and seating surface.
8. Check for approach angle to avoid rubbing of machine surface by the tool.

Steps for facing

Step1: Clamp the work piece on the chuck.
Step2: Turn on the main switch to rotate the spindle and check for trueness
Step3: Mount the cutting tool in the tool post and check for the center height.
Step4: Select the required spindle speed by changing the belt position in the pulley or by changing the gear shifter lever.
Step5: Move the slide closer to the starting position of the work piece.
Step6: Touch the tool on the work piece face and note the reading on the dial mounted on the hand wheel of longitudinal slide.
Step7: Pull out the tool away from work piece by moving the longitudinal slide.
Step8: Move the cross slide to operator’s side to a convenient position for start facing.
Step9: Adjust the longitudinal slide by adding needed depth of cut.
Step10: Switch ON the spindle.
Step11: Move the cross slide towards the center for face turning the work piece by rotating hand wheel of cross slide, up to the center till the disappearance of any pip.
Step12: Pull out the tool away from the work piece by moving the longitudinal slide by rotating the hand wheel.
Step13: Move the apron to right side to a convenient position by rotating the hand wheel.
Step14: Stop the spindle and measure the machined length/ thickness using micrometer or vernier calliper.
Step15: Compare present machined length/ thickness and the drawing dimension for deciding further steps of cut.
Step16: Repeat step 11 to 15 till correct dimensions are achieved.
Elaborate

**Defects in faced work**

- **Concave face:** The cause for this defect is the tool digging into the work during the feeding because the tool is not clamped rigidly. By clamping the tool rigidly with a minimum overhang, this defect may be avoided.

- **A Convex Face:** The cause for this defect is the tool’s cutting edge being blunt or getting blunt during its travel and the carriage not being locked. To avoid this defect you must re-sharpen the tool and use it. Also, lock the carriage to the bed of the lathe.

- **A Pip in the Center:** This is due to the tool not being set to the centre height, and this defect can be avoided by placing the tool to the centre height.

Activity

- Conduct a skill practice activity.
- Ask the students to assemble together.
- Explain the purpose and duration of the activity.
- Set guidelines pertaining to discipline and expected tasks.

<table>
<thead>
<tr>
<th>Skill Practice</th>
<th>Time</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facing operation on given workpiece</td>
<td>4 hours</td>
<td>CNC Lather machine, workpiece and facing tool</td>
</tr>
</tbody>
</table>

Do

- Divide the class into groups.
- Go around and make sure they are doing it properly.

Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
At the end of this unit, you will be able to:

1. Perform turning between centers.

Resources to be Used

- Available objects such as white board, white board marker pens, duster, Participant manual.
- PC with LCD Projector or Flip chart
- CNC Lathe machine, workpiece, turning tool

Do

- Greet and welcome the participants to the next unit of the program.

Say

- In this session we learn about turning between centers.
- A lathe centre is a tool that has been ground to a point to ensure a work piece is accurately positioned on an axis. The centre facilitates concentric work, allowing for the transfer between machining operations without compromising on accuracy.
- The shaft type work pieces which require geometrical accuracy on longer lengths are turned holding them between centers fixed in headstock and tailstock. Rotating the work piece positively is done through a driving plate fixed in the headstock and a removable carrier fixed on the work piece connecting the work piece and the spindle.
- A centre is used to support longer work piece where the cutting forces would deflect the work excessively, reducing the finish and accuracy of the work piece or creating a hazardous situation. Wherever a centred work piece is utilised, a centre may be applied.
- The term between centres refers to any machining operation where the job needs to be performed using centres.
Types of Lathe Center

- **Dead Center**: A dead centre does not turn liberally. It can support the work piece either at the rotating end of the machine or at the fixed end. A dead centre brings about friction between the work piece and centre because of rotation when used in the fixed position. As a result, lubrication is required. To cut down slightly on friction and ensure faster speeds, the tip of the centre may have an inset of cemented carbide.

  These centers are typically fully hardened to prevent damage to the important mating surface of the taper and to preserve the 60 degree angle of the nose.

- **Ball tipped center**: This ordinary center is the type of center used for most general work. In the ball tipped center, the ball point consists of a hard alloy tip brazed into an ordinary steel shank.

  The ball tipped center is more expensive types of center, one which will give excellent service against wear and strain. Another important trait of these centers is that they are used to minimize wear and strain on the ordinary center except that little less than half of the center has been ground away.

- **Live or revolving center**: To ensure that the 60° centre works in its own bearings and is utilised at the non-driven end of the machine, a live centre or revolving centre is manufactured. It facilitates higher turning speeds and greater clamping pressures without the need for separate lubrication.

  This type of centre is used exclusively by CNC lathes, though they also find application in general machining operations. Spring-loaded live centres are made to provide cover for centre variations, while not damaging the work piece or centre tip. This allows for uniform constant tension while machining. Certain live centres also feature interchangeable shafts. This feature is very important when conditions require a design other than a 60° male tip.

- **Pipe centre**: It is also known as a bull nose centre, a pipe centre is a type of live centre which features a big diameter conical nose in place of a sharp point. This allows the centre to be used in the bore of pipe or other work piece with a large interior diameter.

  The main advantage of a pipe center is that it supports the work piece securely, and can be used for parts whose larger inner diameter prevents the use of a normal pointed center.

- **Cup center**: They are of two types. The woodworking type belongs to the family of the traditional live centre. Built like a normal live centre with a central point, this type of cup centre also possesses a ring around it. This ensures the wood does split under pressure from the central point as the ring supports the softer material around the centre point. The cup centre for metalworking is of a different type. It does not have a conical point but sports a tapered hole. Rather than use a centre hole, it supports the part by making contact with the outside diameter of the end of the part.

- **Drive centre**: It is utilised in the driving end of the machine. It consists of hardened teeth that surround a dead centre. These teeth bite into the softer work piece allowing the work piece to be driven directly by the center.

  This ensures only a single operation is required to machine the full diameter of the work piece.
These are often used in woodworking or where softer materials are machined. Drive centers are also known as grip centers in some industrial circles.

- **Spring center**: A metalworking lathe centre that maintains a cutting tool like a tap or a reamer axial alignment with a hole being worked on is known as a spring centre. It consists of a point backed by a spring to push the cutting tool into the work piece.

**Lathe dog and drive plate**

The device that allows the transmission of the rotary motion of the machine’s spindle to the work piece by clamping around the work piece is known as the **lathe dog**. Also known as a lathe carrier, it is most of the time utilised between centres on a lathe but may also be used on dividing heads or in any similar conditions.

It is used along with a **drive plate** and drive pins. The drive pin is attached to the plate, which is mounted directly on the machine spindle (with a chuck). When in use, the carrier and work piece are inserted between centres and the leg of the carrier rests against the drive pin.

Carriages are of two types – straight leg and bent leg. The bent leg fits into a slot machined into the drive plate while the straight leg requires the drive pin.

The **drive plate**, mounted on the spindle nose, works with the driving dog to drive the workpiece between centres. It is a circular disc made out of cast iron having a slot at its face. The slot is there to accommodate a pin which engages with the tail of lathe dog or carrier when a job is held in between center.

**Demonstrate**

**Procedure of turning between centers**

1. Mount the driving plate and center on the headstock.
2. Mount the carrier on to the shaft (outside the machine).
3. Place the assembly locating the carrier at the correct position in the driving plate and work piece center hole resting on the headstock center; hold this assembly. Then, rotate the tailstock hand wheel for positioning the center on the center hole of the work piece.

One you have performed these three steps, then perform OD turning and facing operation as discussed in previous units.
**Activity**

- Conduct a skill practice activity.
- Ask the students to assemble together.
- Explain the purpose and duration of the activity.
- Set guidelines pertaining to discipline and expected tasks.

<table>
<thead>
<tr>
<th>Skill Practice</th>
<th>Time</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turning between centers on given workpiece</td>
<td>4 hours</td>
<td>CNC Lather machine, workpiece and turning tool</td>
</tr>
</tbody>
</table>

**Do**

- Divide the class into groups.
- Go around and make sure they are doing it properly.

**Notes for Facilitation**

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
At the end of this unit, you will be able to:

1. Perform the operation of taper turning.

UNIT 4.6: Taper Turning

Unit Objectives

At the end of this unit, you will be able to:

1. Perform the operation of taper turning.

Resources to be Used

- Available objects such as white board, white board marker pens, duster, Participant manual.
- PC with LCD Projector or Flip chart
- CNC Lathe machine, workpiece, turning tool

Do

- Greet and welcome the participants to the next unit of the program.

Say

- In this session we learn about taper turning.
- A uniform increase or decrease in dimension of the work piece along its length from one end to another is called taper.
- The taper elements are generally designated by a number of symbols including:
  - \( D \) = large diameter of taper in mm
  - \( d \) = small diameter of taper in mm
  - \( l \) = length of tapered part in mm
  - \( 2\alpha \) = Full taper angle
  - \( \alpha \) = angle of taper or half taper angle
- Tapers are of following types: Standard taper and metric taper.
- Standard tapers adapted by the bureau of Indian standard for various tools and machine parts like drills, reamers, lathe cutter shanks, arbors, lathe centers, etc.
There are various types of methods to make a part tapered:
- Taper turning by swiveling compound slide
- Taper turning by form tool
- Taper turning by tailstock off set method
- Taper turning by using taper turning attachment
- Taper turning by combination feed movement

How is the amount of taper in a work piece usually specified?
The amount of taper in a work piece is usually denoted as the relationship between the differences in diameters of the taper to its length. This is known as conicity and it is denoted by the letter K.

\[ K = \frac{D - d}{L} \]

For example: In the figure
Let \( D = 100 \text{ mm}, \ d = 90 \text{ mm}, \) and \( l = 100 \text{ mm}, \) find the value of \( K. \)

\[ K = \frac{100 - 90}{100} = \frac{10}{100} = 0.1 \]

This 1/10 means that the amount of the taper is reduced by 1 mm. The amount of taper 1/10 may also be expressed as a decimal i.e. 0.1. The equation may be rearranged in various ways to calculate any one of the unknown quantities.

\[ L = \frac{D - d}{K} \]

If the large diameter, the small diameter and the conicity are known the length of the taper can be calculated.

Types of Tapers
- **Standard taper**: It is the first and most basic type of taper. The machine parts and tools having inside or outside taper are standardized to facilitate interchangeability of parts. Tapered surfaces which follow standard dimensions are called standard tapers. These tapers are available in seven sizes numbered: 0, 1, 2, 3, 4, 5 and 6.
- The amount of taper varies from number to number. The no.0 (zero) is the smallest while No. 6 is the largest in size.
- **Metric tapers**: They are made in seven sizes and designated by the number 4.6, 80, 100, 120, 160 and 200. The taper number shows the large diameter of the taper in mm.
The amount of taper and taper angle for standard tapers is as follows:

<table>
<thead>
<tr>
<th>Standard Tapers</th>
<th>Amount of Taper or Conicity</th>
<th>Half Taper Angle</th>
<th>Full Taper Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1:19.212</td>
<td>1029°27'”</td>
<td>2058°54’”</td>
</tr>
<tr>
<td>1</td>
<td>1:20.047</td>
<td>1025°43’”</td>
<td>2051°26’”</td>
</tr>
<tr>
<td>2</td>
<td>1:20.020</td>
<td>1025°50’”</td>
<td>2051°41’”</td>
</tr>
<tr>
<td>3</td>
<td>1:19.922</td>
<td>1026°16’”</td>
<td>2052°32’”</td>
</tr>
<tr>
<td>4</td>
<td>1:19.254</td>
<td>1029°15’”</td>
<td>2058°31’”</td>
</tr>
<tr>
<td>5</td>
<td>1:19.002</td>
<td>1030°26’”</td>
<td>3000°53’”</td>
</tr>
<tr>
<td>6</td>
<td>1:19.180</td>
<td>1029°36’”</td>
<td>2059°12’”</td>
</tr>
<tr>
<td>Metric tapers: No.s 4,6,8,100,120,160,200</td>
<td>1:20</td>
<td>1025°26’”</td>
<td>2051°51’”</td>
</tr>
</tbody>
</table>

Table 4.6.1: Types of Tapers

There are two other important standard tapers:

- **Brown and Sharpe standard taper**: The Brown and Sharpe standard taper is used mostly on lathe machines. There are 18 sizes in the series, numbered from 1 to 18. In this standard, the taper is 0.500 in per ft in all of its numbers except the no. 10 which has a taper of 0.5161 in per ft.
- **Jarno standard taper**: The Jarno system of taper is the most sensible system. This was originally designed for use in lathes. There are 20 sizes in the series, each one

---

**Demonstrate**

**Taper Turning by Swiveling Compound Slide**

1. Refer to the drawing for amount of taper required in degrees.
2. Loosen compound rest lock screws.
3. Swivel compound rest as follows.
4. Tighten compound rest lock screws.
5. Set cutting tool to center with tool holder at right angles to taper to be cut.
6. Tighten tool post securely.
7. Back off top slide of compound rest so there will be enough travel to machine length of taper.
8. Move carriage to position cutting tool near start of taper and then lock carriage.
9. Rough turn taper by feeding cutting tool using compound rest feed handle.
10. Check taper for accuracy and readjust compound rest setting if necessary.

11. Finish-turn and check taper for size and fit.

Taper Turning by Form Tool

Form tool has a cutting edge formed at the desired angle. The form tool is a replica of the shape (Taper angle) to be produced on the work piece. The form tool is fed against a rotating work piece; the shape of the tool is reproduced on the work piece.

Taper Turning by Tailstock Off-set Method

1. Adjust tailstock spindle distance; it will be used in matching setup and lock tailstock spindle clamp.
2. Mount a dial indicator in tool post with plunger in horizontal position and on center.
3. Using cross feed handle, move indicator so register 0.020 in on work and set indicator and cross feed graduated collar to zero.
4. Loosen tailstock clamp nut.
5. With tailstock adjusting setscrews, move tailstock until required offset is shown on dial indicator.
6. Tighten tailstock setscrew that was loosened, making sure indicator reading does not change.
7. Tighten tailstock clamp nut.

Note: Tailstock may also be offset by using feeler gauge between tool post and tailstock.

Taper Turning Using Taper Turning Attachment

1. Clean and oil guide bar.
2. Loosen lock screws and offset end of guide bar the required amount or set bar to required taper in degrees.
3. Tighten lock screws.
4. With compound rest set at 90°, setup cutting tool on the center.
5. Set work piece in lathe and mark length of the taper.
6. Tighten connecting screw on sliding block.
7. Move the carriage until the center of attachment opposite length be tapered.
8. Lock anchor bracket to lathe bed.
9. Take cut 15 mins long, stop lathe, check end of taper size.
10. Set depth of roughing cut to 0.5 to 0.6mm oversize and machine taper.
11. Readjust taper attachment, if necessary, take light cut and recheck taper fit.
12. Finish turn and fit taper to gauge.
Activity

- Conduct a skill practice activity.
- Ask the students to assemble together.
- Explain the purpose and duration of the activity.
- Set guidelines pertaining to discipline and expected tasks.

<table>
<thead>
<tr>
<th>Skill Practice</th>
<th>Time</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perform taper turning by all four methods</td>
<td>4 hours</td>
<td>CNC Lather machine, workpiece and taper turning tool</td>
</tr>
</tbody>
</table>

Do

- Divide the class into groups.
- Go around and make sure they are doing it properly.

Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
At the end of this unit, you will be able to:

1. Perform drilling operation.

UNIT 4.7: Drilling

Unit Objectives

At the end of this unit, you will be able to:

1. Perform drilling operation.

Resources to be Used

- Available objects such as white board, white board marker pens, duster, Participant manual.
- PC with LCD Projector or Flip chart
- CNC Lathe machine, workpiece, drilling tool.

Do

- Greet and welcome the participants to the next unit of the program.

Say

- In this session we learn about drilling.
- Drilling is the process to produce a hole in a solid work piece using a cutting tool called drill.
- In drilling, work piece is held on the chuck is rotated and the drill mounted on the tailstock is moved by rotating the tailstock handle to produce the hole in the center of the work piece.
- The drills are made up of HSS tools.
- The holding portion of drill is straight or tapered. Straight drills are called parallel shank drills. The Tapered shanks are provided with Morse Taper with varying diameters.
- Parallel Shank Drills are clamped using a drill chuck with key and inserted into the taper socket provided in the tailstock. Taper shank drills are either inserted directly into the tail stock or using intermediary Morse Taper bushes.
- Centre drilling is an operation through which small drill holes are produced to locate the centre of the hole on the solid flat surface by means of a cutting tool known as combination drill or center drill.
- Drill materials are HSS, HSS – Co, TiALN coating and carbide. Centre Drills are available with: Combined drills, reinforced bulge, radius form, etc.
• To create cylindrical holes with circular cross-section, cutting tools such as drill bits are used.

• A large proportion of drill bits for consumer use come with straight shanks. Bits with tapered shanks are at times used in heavy-duty drilling in industry.

• Drills bits come in standard sizes. Speeds and feeds are selected based on the work piece material, tool material and length of the drill hole on the work piece.

• When drilling, it is very important to use soluble oil as a coolant. To maintain cooling, this should be constantly fed onto the drill bit. This will help prevent jamming and overheating. Over heating will blunt the drill bit quickly.

Elaborate

Center Drilling

When the hole is longer in the work piece; center drilling is done before drilling. Centre drilling creates small conical centre which aids in locating the drill in subsequent drilling operation and avoid wobbling of drill during entry. Work piece held on the chuck is rotated and the drill mounted on the tailstock is moved by rotating the tailstock handle to produce the hole in the center of the work piece.

Centre drill is the tool which is used to make a small hole to locate the centre for the proceeding drill holes. The material of centre drill used in the workshop is HSS. Centre and spotting drills are usually used to help prevent the twist drill from walking by making a conical hole for a lathe centre to create a starting point for a standard twist drill.

Drill Bit

A drill holds these bits and rotates them, creating the hole via generation of torque and axial force. The shank is at one end of the drill bit and the cutting edges are at the other end.

Shank is the part of the drill bit grasped by the chuck of the drill. The cutting edges of the drill bit are at one end, and the shank is at other.

The rate of chip removal is controlled by the spiral (or rate of twist) in the drill bit. Low spiral drill bits are used with high cutting speeds while a fast spiral drill bit is used under low spindle speeds. Applications that use low spiral drill bits face situations where the material tends to clog the hole, such as aluminium or copper.

The material that the bit will be operating in will dictate the Point Angle, or the angle formed at the tip.
of the bit. Softer materials need a sharper point angle while harder materials need a larger point angle.

The amount of support offered to the cutting edge is dictated by the Lip Angle. A larger lip angle facilitates aggressive cutting under the same amount of point pressure held with a smaller lip angle. The point angle dictates the appropriate amount of lip clearance. A flat bit is easily impacted by small changes in lip angle due to small surface area.

The depth of a hole is dictated by the length of the bit, which also determines the accuracy of the hole and the stiffness of the bit. Twist drill bits are available in standard lengths – Stub-length or Screw-Machine-length (short), Jobber-length (medium), and Taper-length or Long-Series (long).

The diameter-to-length ratio of the drill bit is usually between 1:1 and 1:10. Though high ratios can be achieved, the technical challenge of ensuring good results increases as the ratios go higher.

---

**Demonstrate**

**Center Drilling in Lathe**

1. Hold the work in a four jaw chuck about 50 mm outside and true.
2. Finish faces the work with a facing tool.
3. Ensure no ‘pip’ is left out in the centre and the face is at right angles to the axis.
4. Mount the drill chuck in the tailstock spindle.
5. Remove dirt on the taper shank of the chuck and the tailstock spindle taper bore.
6. Mount a suitable centre drill securely in the drill chuck. Set the lathe to about 1000 r.p.m.
7. Slide the tailstock over the bed until the centre drill is close to the work face.
8. Lock the tailstock in this position.
9. Start the machine and slowly feed the centre drill into the work by rotating the tailstock hand wheel.
10. Withdraw the drill frequently from the work piece to clean the chips and to apply the cutting fluid.
11. Continue drilling until about three fourths of the tapered portion of the centre drill has entered the work.
12. Ensure that uniform continuous pressure is applied during feeding and no extra force is given.

**Using the Tailstock for Drilling**

1. Work piece held on the chuck is rotated and the drill mounted on the tailstock is moved by rotating the tailstock handle to produce the hole in the center of the work piece.
2. Using a countersink bit is the first step for drilling with a centre lathe. The aim of using a countersink is to drill slightly into the material before using other drills.

3. If a long piece of material has to be turned on a lathe then a centre drill is used to produce the hole at one end. This allows the drilled end to be supported by the tailstock centre.

4. After using the centre drill to create a hole, one can shift to using machine twist drills to make the hole bigger or drill all the way through. A small hole (eg. 4mm dia) is drilled at first, if there is a requirement for a large diameter hole.

5. After this, the hole is enlarged around 2mm at a time. One cannot drill a large diameter hole in one go as it may expose the drill bit to over-heating while also jamming the material, which is harmful.

Activity

• Conduct a skill practice activity.
• Ask the students to assemble together.
• Explain the purpose and duration of the activity.
• Set guidelines pertaining to discipline and expected tasks.

<table>
<thead>
<tr>
<th>Skill Practice</th>
<th>Time</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perform drilling on given workpiece</td>
<td>4 hours</td>
<td>CNC Lather machine, workpiece and drilling tool</td>
</tr>
</tbody>
</table>

Do

• Divide the class into groups.
• Go around and make sure they are doing it properly.

Notes for Facilitation

• Summarize the main points.
• Ask participants if they have any doubts.
• Encourage them to ask questions.
• Answer their queries satisfactorily.
• Tell participants to complete the questions at the end of the unit.
• Ensure that every participant answer all the questions.
UNIT 4.8: Boring

Unit Objectives

At the end of this unit, you will be able to:

1. Perform the boring operation.

Resources to be Used

- Available objects such as whiteboard, white board marker pens, duster, Participant manual.
- PC with LCD Projector or Flip chart
- CNC Lathe machine, workpiece, boring tool

Do

- Greet and welcome the participants to the next unit of the program.

Say

- In this session we learn about boring operation.
- In machining, when one uses a single-point cutting tool (or of a boring head containing several such tools) to make a hole, which has already been drilled (or cast), even bigger, the said process is referred to as boring.
- Boring can be used to cut a tapered hole, though it is generally used to ensure greater precision of the diameter of the hole.
- Boring can be considered a counterpart to turning as boring focuses on internal diameters while turning focuses on external diameters.
- The boring bar may be supported at one end or at both ends. Back boring involves boring on the rear side of the work piece after reaching through an existing hole.
- To produce accurate holes, boring is vital.
- Defectiveness in the material causes drills to move out of alignment. Hence, to ensure precision, drilled holes are generally made undersize. Following this, the hole is bored or reamed to gain the appropriate dimensions.
• One should clamp the boring tool bar as close to the holder and tool post as possible, keeping in mind the depth of boring to be made. The bar will have a tendency to spring away from the work piece if the bars over hang the tools post too far.

• A soft or semisoft bar called a boring tool bar is generally used to hold the bit. A cutting holder, which fits into the lathe tool post, is utilised to support the boring tool bar. Boring tool bars are supplied in several types and sizes for holding different cutter bits.

• The nature of the work piece being bored dictates the angle that the bit is supported in the boring tool bar – be it a 90°, 30°, or 45° angle. Most boring activities are usually undertaken with a 90° cutter bit. When one needs to finish the side of an internal shoulder or cut up to the bottom of a hole, the bit is mounted at a 30° or 45° angle to the axis of the boring tool bar.

• The cutter bits that are used for boring are shaped like left-hand turning and facing cutter bits. Greater attention must be given to the end clearance angle and the back rake angle because of the curvature of the hole.

---

**Elaborate**

**Mounting Workpiece for Boring**

Boring involves the use of a single point cutter bit towards the enlarging and truing of a hole by removing material from internal surfaces. Boring is achieved on the lathe by either of the following two methods:

1. Revolving the work piece after straddling the holder and boring tool bar with cutter bit on the tool post.
2. Revolving the boring tool bar and cutter bit in a chuck attached to the headstock spindle after straddling the work piece in a fixed position (This is a special process and not used in most machine shops).

The type of material to be machined dictates whether the work piece may be supported in a chuck or fastened to a faceplate for boring operations.

When boring is undertaken on the ends of long stock, the work piece is straddled in a chuck and the right end near the cutter bit is supported by a steady rest.

---

**Demonstrate**

**Boring Operation**

1. Clamp the work piece on the chuck.
2. Turn on the main switch to rotate the spindle and check for trueness.
3. Mount the boring tool in the tool post and check for the center height.
4. Select the required spindle speed by changing the belt position in the pulley or by changing the gear shifter lever.
5. Move the slide closer to the starting position of the work piece.
6. Touch the tool on the work piece inside diameter and note the reading on the dial mounted on the hand wheel of cross slide.
7. Pull out the tool, away from the work piece by moving the cross slide.
8. Move the longitudinal slide to the right side for a convenient position for start turning.
9. Adjust the cross slide by adding the needed depth of cut.
10. Switch ON the spindle.
11. Move the longitudinal slide to the left side for boring on the work piece by rotating the hand wheel, up to required length.
12. After reaching the required length pull out the tool, away from the work piece by moving the cross slide by rotating the handwheel. Unlike in OD turning the boring tool has to be pulled out from the contact surface for a smaller distance since the boring tool will collide on the wall of the machined bore.
13. Move the apron to the right side to a convenient position by rotating the handwheel.
14. Stop the spindle and measure the machined bored size using the micrometer or vernier calliper.
15. Compare present machined bore size and the drawing dimension for deciding further steps of cut.
16. Repeat step 11 to 15 till correct dimensions are achieved.

Activity

- Conduct a skill practice activity.
- Ask the students to assemble together.
- Explain the purpose and duration of the activity.
- Set guidelines pertaining to discipline and expected tasks.

<table>
<thead>
<tr>
<th>Skill Practice</th>
<th>Time</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boring operation on given workpiece</td>
<td>4 hours</td>
<td>CNC Lather machine, workpiece and boring tool</td>
</tr>
</tbody>
</table>
Do

- Divide the class into groups.
- Go around and make sure they are doing it properly.

Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
At the end of this unit, you will be able to:

1. Identify the tools with reference to the external grooving operation;
2. Perform the operation.

UNIT 4.9: External Grooving

Unit Objectives

Resources to be Used

- Available objects such as whiteboard, white board marker pens, duster, Participant manual.
- PC with LCD Projector or Flip chart
- CNC Lathe machine, workpiece, boring tool

Do

- Greet and welcome the participants to the next unit of the program.

Say

- In this session we learn about external grooving operation.
- External grooving is the process of turning in which a groove is created on the outer diameter, the details of the groove needs to be clarified in the component drawing.
- The details of grooving needs to be clarified in the component drawing. The groove thus cut on the OD can have following features:
  1. Width of the Groove.
  2. Depth of the Groove.
- The tool for turning the groove is selected on the basis of its features.
External Grooving Operation

1. Select the External Groove Cutting tool carefully.
2. Fix the selected External groove tool in the tool holder, ensure minimum overhanging of the tool, and set the cutting tip height of the tool with respect to the turning axis of the machine.
3. Start the machine after selecting the RPM of the machine and ensure correct direction of rotation.
4. Take a skin touch at the point of external groove and measure the placement of the groove position.
5. If the same is OK, lock the carriage for transverse movement and give only the plunge cuts to achieve the inner diameter or the width of the groove as required by the component drawing.

Activity

- Conduct a skill practice activity.
- Ask the students to assemble together.
- Explain the purpose and duration of the activity.
- Set guidelines pertaining to discipline and expected tasks.

<table>
<thead>
<tr>
<th>Skill Practice</th>
<th>Time</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>External grooving operation on given workpiece</td>
<td>3 hours</td>
<td>CNC Lather machine, workpiece and grooving tool</td>
</tr>
</tbody>
</table>

Do

- Divide the class into groups.
- Go around and make sure they are doing it properly.

Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
UNIT 4.10: Internal Grooving

Unit Objectives

At the end of this unit, you will be able to:
1. Identify the tools with reference to the Internal grooving operation;
2. Perform the operation.

Resources to be Used

- Available objects such as whiteboard, white board marker pens, duster, Participant manual.
- PC with LCD Projector or Flip chart
- CNC Lathe machine, workpiece, grooving tool

Do

- Greet and welcome the participants to the next unit of the program.

Say

- In this session we learn about internal grooving operation.
- Internal grooving means creating a groove inside the piece on the Inner Diameter, the grooves needs to be clarified in the component drawing.
- The groove thus cut on the OD can have following features:
  1. Width of the Groove.
  2. Depth of the Groove.
- The tool for turning the groove is selected on the basis of its features.
**Demonstrate**

**Internal Grooving Operation**

1. Select the Internal Groove Cutting tool carefully.
2. Fix the selected Internal groove tool in the tool holder, ensure minimum overhanging of the tool, and set the cutting tip height of the tool with respect to the turning axis of the machine.
3. Start the machine after selecting the RPM of the machine and ensure correct direction of rotation.
4. Take a skin touch at the point of internal groove and measure the placement of the groove position. It can be controlled by the Drum movement of the cross slide.
5. If the same is OK, lock the carriage for transverse movement and give only the plunge cuts to achieve the inner diameter or the width of the groove as required by the component drawing.

**Activity**

- Conduct a skill practice activity.
- Ask the students to assemble together.
- Explain the purpose and duration of the activity.
- Set guidelines pertaining to discipline and expected tasks.

<table>
<thead>
<tr>
<th>Skill Practice</th>
<th>Time</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal grooving operation on given workpiece</td>
<td>3 hours</td>
<td>CNC Lather machine, workpiece and grooving tool</td>
</tr>
</tbody>
</table>

**Do**

- Divide the class into groups.
- Go around and make sure they are doing it properly.

**Notes for Facilitation**

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
UNIT 4.11: Fundamentals of Thread Cutting In Lathe

Unit Objectives

At the end of this unit, you will be able to:

1. State the elements of thread cutting.

Resources to be Used

- Available objects such as whiteboard, white board marker pens, duster, Participant manual.
- PC with LCD Projector or Flip chart

Do

- Greet and welcome the participants to the next unit of the program.

Say

- In this session we learn about fundamentals of thread cutting.
- A screw thread, often shortened to thread, is a helical ridge formed on inside or outside of cylinder or cone. The threads can be made (or cut) both on external surface or internal surface to obtain respectively the external threads or internal threads.
- Threads have several applications:
  - Fasten devices such as screws, bolts, studs, and nuts
  - Provide accurate measurement, as in micrometer
  - Transmit motion
  - Increase force
- Threads are of various types depending on its end use. Some of the commonly used threads are:
  1. ISO Metric Thread
  2. Square Thread
  3. Acme Thread
- An isometric thread is the most common thread to be cut, and once you can cut it, no other thread (internal, external, acme, square, etc.) is beyond reach.
Thread Terminology

- **Straight Thread**: Thread formed on a cylinder.
- **Taper thread**: Thread formed on a cone.
- **External Thread**: An external thread is a thread on the external surface of a cylinder screw or cone.
- **Internal Thread**: An internal thread is a thread on the internal surface of a cylinder screw or cone.
- **Major Diameter**: Commonly known as the outside diameter. On a screw thread, the major diameter is the largest diameter of the thread on the screw or nut. We also use the term full diameter when we talk about the thread of a nut.
- **Minor Diameter**: Commonly also called the root or core diameter. It is the smallest diameter of the thread of the screw or nut.
- **Pitch Diameter**: On a straight thread, the diameter of an imaginary cylinder that passes through thread at a point through the threads at such points where the width of the thread and groove are equal.
- **Number of Threads**: The number of threads per inch.
- **Pitch**: The distance from a point on a screw thread to a corresponding point on the next thread measured parallel to the axis. This distance can be measured in millimeters or by the tpi (threads per inch) which is the reciprocal of the pitch. Simply said:

  The pitch in inches is = 1 / the number of threads per inch.

- **Lead**: The distance a screw thread advances in one revolution. On a single threaded screw the lead and pitch are identical; on a double threaded screw the lead is two times the pitch; on a triple headed screw the lead is three times the pitch, etc.
- **Crest**: Top surface joining two sides of thread. (External thread on major diameter and internal thread on minor diameter)
- **Root**: The bottom surface joining sides of two adjacent threads. (External thread on minor diameter and internal thread on major diameter)
- **Side or Flank**: The surface of the thread which connects the crest with the root.
- **Axis of a Screw**: The longitudinal central line through the screw.
- **Half Angle of Thread**: The angle included between a side of the thread and the normal to the axis, measured in an axial plane.
- **Angle of Thread**: The angle included between the sides of the thread measured in an axial plane.
- **Helix Angle**: Angle that the thread makes with a plane perpendicular to thread axis.
- **Base of Thread**: The bottom section of the thread; the greatest section between the two adjacent roots.
• **Depth of Thread**: Distance between crest and root measured perpendicular to axis

• **Right-hand Thread**: When a nut is rotated in clockwise direction looking along axis from the nut and the nut advances on the thread, the thread is right hand.

• **Left-hand Thread**: When a nut is rotated in anti-clockwise direction looking along axis from the nut and nut advances on the thread, the thread is left hand.

**Fig. 4.11.1: Thread Terminology**

**Forms of Thread**

• **ISO Metric Thread**: The basic profile of ISO metric screw thread is shown in the diagram given below. BIS (Bureau of Indian Standard) has adopted the same thread form. In this, the thread angle is 60 degrees. As you can see the face of the root will be twice that of the crest. This is to ensure smooth travel of nut over the screw.

• **Square Thread**: Square thread is an ideal thread form for power transmission. In this, the thread flank is at right angle to the axis. This enables the nut to transmit very high pressures, as in the case of a screw jack and other similar applications.

• **Acme Thread**: It is a modified form of square thread. It is much stronger than square thread because of the wider base and it is easy to cut. The thread angle is 29 degrees.

**Ask**

• Ask about different forms of threads.

• Ask about different terms used in thread cutting.
Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
UNIT 4.12: External Threading

Unit Objectives

At the end of this unit, you will be able to:
1. Identify the tools with reference to the External Threading operation;
2. Perform the External Threading operation.

Resources to be Used

- Available objects such as white Board, white board marker pens, duster, Participant manual.
- PC with LCD Projector or Flip chart
- CNC Lathe machine, workpiece, tools

Do

- Greet and welcome the participants to the next unit of the program.

Say

- A thread is a uniform helical groove cut inside of a cylindrical work piece, or on the outside of a tube or shaft. A screw has external thread.
- External threading is the process of threading done externally on a work piece like screw etc.

Demonstrate

Steps to cut external right-hand thread on lathe

Step1: Set the spindle speed at one-quarter the normal turning speed.

Step2: Set the gearbox for the desired transverse feed or pitch.

Step3: Set the lead screw to turn in the forward direction. When engaged, the carriage will move from right to left.
Step 4: Set the tool tip height to center of the lathe axis and the compound slide angle to 30°. (Because we are going to cut a 60° angle metric thread).

Step 5: Mount the work and ensure it is secure and there is no end-to-end play or job is running concentric.

Step 6: Set the tool at right angles to the work using the thread center gauge.

Step 7: Measure and control the diameter of the work. Good practice is to have the work diameter 0.002 inch (0.05 mm) under the thread major diameter.

Step 8: Start the lathe and chamfer the right end of the work to just under the thread final minor diameter using the left edge of the cutting tool.

Step 9: Measure and mark the work where the threads will end by cutting a light ring with the threading tool bit. Crank the tool bit away from the work so the carriage can be moved. The spindle will still be turning.

Step 10: Manually position the carriage toward the right end of the work piece and, using the compound rest, move the tool bit towards the work so it just lightly marks it. Set both the cross slide and compound micrometer collars to zero.

Step 11: Back the tool bit away from the work using the cross slide and position the carriage so the tool bit tip is ¼ inch / 15 mm or more to the right end of the work, the starting point.

Step 12: Using the compound slide, move the tool bit into the work between 0.001 and 0.003 inches (0.05 mm approximately) with your left hand on the compound crank. Engage the half-nut lever with your right hand when the thread dial reaches the right graduation. This will make the first, or scratch/skin pass.

Step 13: When the tool reaches the left end of the cut, quickly crank the tool away from the work piece using the cross slide crank, and disengage the half-nuts.

Step 14: Move the carriage manually back to the starting point and set the cross slide back to the zero position.

Step 15: Stop the spindle, and using either a thread pitch gage or a ruler, check that the cut is the desired pitch. Correct the gearbox setting and try again if the thread count is wrong.

Step 16: Restart the spindle.

Step 17: Manually move the carriage back. Then, using the collar calibrations, move the cross slide to the zero position, with the compound slide, advance the tool bit in preparation for the next thread cut, and repeat the cycle by increasing the depth of cut with each pass.

Step 18: Engage the half-nut lever with your right hand when the threading dial reaches the correct graduation and the tool will move from Position 3, through Position 4, and to the end of the threads at Position 5. When the tool reaches Position 5, use the cross slide to quickly withdraw...
the tool to Position 6. Then manually move the carriage back to Position 1. You are now ready to begin the next cutting pass.

**Step 19:** Tables in Machinery’s Handbook show the final thread depth for all common thread forms. This depth can be read off the compound collar and can be checked using a threading micrometer. Also, thread center gauges have the thread depth for various threads engraved on them.

**Step 20:** Not having this information at hand, the operator can watch the thread develop until the width at the thread bottom (root) just about equals the width of the thread top (crest). Then take additional small cuts until the mating part or master nut fits properly.

**Step 21:** Use a diamond file to remove burrs on the top thread edge.

---

**Activity**

- Conduct a skill practice activity.
- Ask the students to assemble together.
- Explain the purpose and duration of the activity.
- Set guidelines pertaining to discipline and expected tasks.

<table>
<thead>
<tr>
<th>Skill Practice</th>
<th>Time</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>External threading on given workpiece</td>
<td>4 hours</td>
<td>CNC Lather machine, workpiece and tools</td>
</tr>
</tbody>
</table>

---

**Do**

- Divide the class into groups.
- Go around and make sure they are doing it properly.

---

**Notes for Facilitation**

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
UNIT 4.13: Internal Thread Cutting

Unit Objectives

At the end of this unit, you will be able to:

1. Identify the tools with reference to the internal threading operation;
2. Perform the internal threading operation.

Resources to be Used

- Available objects such as white Board, white board marker pens, duster, Participant manual.
- PC with LCD Projector or Flip chart
- CNC Lathe machine, workpiece, tools

Do

- Greet and welcome the participants to the next unit of the program.

Say

- In this session we learn about how to do internal threading.
- The most commonly used tools are commercial boring bars with HSS, alloy steel or tungsten carbide tool bits.
- For holes that are too small for a boring bar, an HSS tool bit blank may be ground into a small, single-piece threading tool.
- Internal threading require square nose tool inside the workpiece. Square nose tool makes easier to start or stop the threading process as there is no abrupt end of the thread.
To start the cutting of internal thread, first need to set the tool bit axis vertical to the work for internal threads. The two ways to check alignment of a tool bit for internal threads are:

Fig. 4.13.1: Two Ways to Check Alignment of a Tool Bit For Internal Threads.

Setup for Cutting Internal Threads Starting from Outside the Work

Fig. 4.13.2: Setup for Cutting Internal Threads Starting From the Outside The Work
Steps to cut internal right-hand threads

Step 1: Place the work in a chuck, collect or face plate and drill a starting hole for the boring tool.

Step 2: Now start drilling or boring a hole of the threads in the work piece. Remember you can even take this diameter from Machinery’s Handbook.

Step 3: If you find that the thread is not running completely through the work then use a square-nose tool inside the work piece to cut a groove where the threads end.

Step 4: It is important to cut a recess in the open end of the work piece which is equal to the thread’s major diameter. This will help you to observe the depth of thread during threading process.

Step 5: You may start threading from either sides that is from outside or from inside the work. If you start threading from inside then you can do away with the problem of not being able to see the internal end of the threads so you know when to open the half-nuts. This method is only suitable on lathes with a long-taper or cam-lock spindle nose which will not unscrew from the spindle when run in reverse under load. You will need to choose one of these methods before installing the boring bar (or single-piece tool bit) with the properly shaped cutting bit in the tool holder, and set the compound at an angle of 30° (in case of a 60° metric thread) to the work axis.
Steps to cut internal threads starting from inside the work

Step 1: Use the tailstock center as a reference to adjust cutter bit height exactly on center. Be sure, that there is sufficient end clearance on the lower face of the cutter bit and there is enough room behind the boring bar and cutter bit. This will assure you that they will not bump into the interior of the work piece when the tool bit is withdrawn from the threads.

Step 2: Fix the spindle and the lead screw to turn forward, that is, to move from right to left. This will enable the tool run into the work.

Step 3: Make the threads like you do in the external threading operations. The only change will be that the cross slide is moved forward to clear the tool, and return the carriage to the starting point. It is helpful to put a mark or piece of tape on the boring tool bit arm or on the ways to indicate the stopping point at the end of the internal threads.

Step 4: Observe the depth of the threads in the lower-level starting area to know when the threads are complete, check with a thread plug gauge or the mating part.

Step 5: Minimize the length of the unsupported boring bar because it will deflect and restrict you from taking smaller cuts. Plan to make the final pass more than 0.001 inch/ 0.02 mm depth as the spring in the bar will make such a small cut impossible.

Activity

- Conduct a skill practice activity.
- Ask the students to assemble together.
- Explain the purpose and duration of the activity.
- Set guidelines pertaining to discipline and expected tasks.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Time</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal threading of given workpiece from outside</td>
<td>4 hours</td>
<td>CNC Lather machine, workpiece and tools</td>
</tr>
</tbody>
</table>

Do

- Divide the class into groups.
- Go around and make sure they are doing it properly.
Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answers all the questions.
At the end of this unit, you will be able to:

1. Identify the tools with reference to the Parting operation;
2. Perform the Parting operation

Resources to be Used

- Available objects such as white Board, white board marker pens, duster, Participant manual.
- PC with LCD Projector or Flip chart
- Workpiece, CNC lathe, tools

Do

- Greet and welcome the participants to the next unit of the program.

Say

- In this session we learn about how to do parting.
- Parting is an operation of cutting off a piece held in the chuck of a lathe.
- Parting is the process of parting off some part of the turned part by the way of plunge cut or cutting a deeper external groove.

Demonstrate

**Process of parting**

1. Select the Parting tool carefully.
2. Fix the selected tool in the tool holder, ensure minimum overhanging of the tool, and set the cutting tip height of the tool with respect to the turning axis of the machine.
3. Start the machine after selecting the RPM of the machine and ensure correct direction of rotation.
4. Take a skin touch at the point of parting and measure the placement of the groove position. It can be controlled by the drum movement of the transverse slide.

5. If the skin touch is ok, lock the carriage for transverse movement and give only the plunge cuts to part away the piece as required.

---

**Activity**

- Conduct a skill practice activity.
- Ask the students to assemble together.
- Explain the purpose and duration of the activity.
- Set guidelines pertaining to discipline and expected tasks.

<table>
<thead>
<tr>
<th>Skill Practice</th>
<th>Time</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parting of given workpiece</td>
<td>3 hours</td>
<td>CNC Lather machine, workpiece and tools</td>
</tr>
</tbody>
</table>

**Do**

- Divide the class into groups.
- Go around and make sure they are doing it properly.

**Notes for Facilitation**

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
5. CNC Turning

Unit 5.1 – Introduction to CNC
Unit 5.2 – Coordinate Systems - Cartesian
Unit 5.3 – Control Systems
Unit 5.4 – G Codes and M Codes
Unit 5.5 – Part Program Development
Unit 5.6 – Throw Away Insert Tools
Unit 5.7 – Mounting of Tool Holders on turret
Unit 5.8 – Tool Number and Offset Number
Unit 5.9 – Work Holding
Unit 5.10 – Workpiece Settings
Unit 5.11 – Fault Tracing Techniques
Unit 5.12 – Routine Preventive Measures
At the end of this module, students will be able to:

1. State the importance of CNC;
2. Apply the knowledge of Cartesian system to hold the tool in the correct position;
3. Understand G codes and their functions;
4. Understand M codes and their functions;
5. Align the piece with respect to the machine axis;
6. Explain importance of 5S;
7. Describe 5S activities;
8. Select the appropriate method for clamping the workpiece;
9. Align the piece with respect to the machine axis;
10. Identify the error code;
11. Perform the operation to rectify the error;
12. State the do's and don’ts of daily and weekly maintenance.
UNIT 5.1: Introduction to CNC

Unit Objectives

At the end of this unit, you will be able to:

1. State the importance of CNC.

Resources to be Used

- Available objects such as white board, white board marker pens, duster, Participant manual.
- PC with LCD Projector or Flip Chart

Do

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

- Now Sailesh is going to learn about NC system and CNC machine in this unit.
- NC stands for Numerical Control and it is a method of automatically operating a machine tool by means of numbers, letters and symbols that controls movements through some form of an input medium.
- Input medium can be a punched tape, a direct wire from computer magnetic tapes and diskettes.
- The common types of NC systems used in machine tools are:
  - Conventional NC
  - Computer numerical Control (CNC).
  - Direct numerical Control (DNC).
- Conventional NC is a hard wired based system, employing integrated circuits which are permanently wired and arranged on printed circuit board. Also this NC system is purely a hard wire based system. It is not easy to change the main features of its machine control unit.
- Computer numerical Control (CNC) is a software based system, in which the computer replaces the control unit of the conventional NC. It does not carry the hard wired logic systems, and all their functions for controlling the machine tool are performed by the software programme of the Computer.
Applications of NC System

1. Machining of such components which require 100% inspection.
2. Repetitive production of Precision parts in small and medium lot sizes.
3. When several operations are to be performed in machining of a part.
4. When complex machining operations are involved.
5. When the amount of metal to be remove is high.
6. When economic considerations demand a substantial reduction in “lead time” for the manufacture.
7. When Jig and Fixture involvement is high.
8. When dimensional accuracy of the part is very high.

Advantages of NC System

• Increased Productivity
• Less Rejection
• Increased Rate of Production
• Reduced Non-Productive Time
• Reduced Inspection Requirement
• Higher Accuracy
• Better Quality Control
• Ease of Complex Machining
• Greater Utilization of Manpower
• Reduction of Human Errors
• Safety of Operator
• Safety of Machine Tool
• Accurate Estimation
• No Need of Skilled Operator

Direct numerical Control (DNC) is also a computerized Numerical Control System, but it differs from a CNC system in that it employs a separately located Central Computer and directly controls several machines simultaneously.
**Limitations of Numerical Control**

- A relatively high price for the NC machine.
- More complicated maintenance, a special maintenance crew is desirable.
- A highly skilled and properly trained programmer is needed.
- Redundancy in labor may be there.

**Ask**

- You could ask about NC.
- You could ask about CNC and conventional NC.
- You could ask about applications of NC system.
- Ask about advantages and limitations of NC system.

**Notes for Facilitation**

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
UNIT 5.2: Coordinate Systems - Cartesian

Unit Objectives

At the end of this unit, you will be able to:

1. Apply the knowledge of Cartesian system to hold the tool in the correct position.

Resources to be Used

- Available objects such as white board, white board marker pens, duster, Participant manual.
- PC with LCD Projector or Flip Chart

Do

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

- Today Mohan is going to explain about Cartesian co-ordinate system to Sailesh.
- As an operator on CNC machine, it becomes necessary to program and perform the Cartesian co-ordinate system.

Elaborate

Coordinate Systems – Cartesian

Let’s understand with an example - You are sitting in a room and when you look around you’ll see at least 6 different planes on our sides, up and down. Above you is the roof and below you is the floor; If you see one of the corners there are 3 lines emerging from a common point. Each of this line denotes an axis/ direction and if you name it you will say X, Y and Z axis.

Each axis has a zero point or a reference point and the plus and minus side of the same.

Fig. 5.2.1: Operators Working Grid
Imagine that an operator is standing in front of this figure. He will have X and Y axis in front of him. Now, he can see four quadrants that are formed namely (X Positive Y positive), (X negative and Y positive), (X negative and Y negative) and (X positive and Y negative). This is called 2D Cartesian coordinate systems.

### 3D Coordinate Systems- Cartesian

When we add one more axis called Z axis to the present two axes X and Y, it becomes 3D.

Choosing a Cartesian coordinate system for a three-dimensional space means choosing an ordered triplet of lines (axes), any two of them being perpendicular; a single unit of length for all three axes; and an orientation for each axis. In two-dimensional case, each axis becomes a number line.

The coordinates of a point p are obtained by drawing a line through p perpendicular to each coordinate axis, and reading the points where these lines meet the axes as three numbers of these number lines.

**Identifying the Location of a Point/ Address**

A 2D shape is made on a planer surface. Hence, it can be plotted easily on the X and Y axis. In case of 2D shapes, X and Y axis are two perpendicular axes which can be marked as per required dimensions on them. The point where X and Y meet is called origin and is generally marked as O.

Each axis has a marking on it used to find the distance between two points. Both the axis run infinitely and includes both positive and negative values.

When we want to plot a 3D shape on the axis we need a third axis called the Z axis to accommodate the third dimension for a 3D shape.

Use a box having 6 faces to find the address of the corners with reference to all the 3 planes X, Y and Z.
Ask

- You could ask about Cartesian co-ordinate system.
- You could ask about 2D Cartesian co-ordinate system.
- You could ask about 3D Cartesian co-ordinate system.

Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
UNIT 5.3: Control Systems

Unit Objectives

At the end of this unit, you will be able to:
1. Identify the machine keys;
2. Start and reference the machine.

Resources to be Used

- Available objects such as white board, white board marker pens, duster, Participant manual.
- PC with LCD Projector or Flip Chart
- CNC lathe machine

Do

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

- The control panel consists of keys to communicate with CNC controller and keys/ buttons/ switches for controlling machine movements and functions.
- Every machine will have a typical operator panel for CNC controller. Program keying in and certain functional setup are performed using this operator panel.
- Machine movements, mode selection, turret position selection in JOG (manual) mode, speed and feed override switches along with machine ON/OFF switches are placed in an adjoining panel to the CNC controller operator panel.

Fig. 5.3.1: Control Panel
Machine control panel consists of

- Machine ON/OFF switch.
- Hydraulic ON/OFF switch.
- Mode selector switch – there are different modes available in a CNC machine. They are – EDIT, AUTO, AUTO SLK (Single Block), TAPE, MDI (Manual Data Input), MPG, JOG, REF (Reference).
- Manual Pulse Controller (MPG)/ Hand Pulse Generator (HPG)/ Electronic hand wheel – used for moving the slides manually during setup operations by rotating the hand wheel.
- Selector Switch for selecting the axis (X, Z) during MPG mode.
- Selector Switch for resolution of slide movement in MPG mode – 0.001mm/ 0.01mm/0.1mm per pulse of MPG.
- Selector Switch for spindle speed override from 0% to 120% from the command value.
- Selector Switch for cutting feed override from 0% to 150% from the command value.
- Selector Switch for rapid feed override from 0%, 50%, 100% from the command value.
- Push buttons for moving slides manually in all the directions in JOG mode – +X, -X, +Z, -Z.
- Auto cycle ON button.
- Auto cycle HOLD button.
- Auto cycle RESET button.
- Spindle ON button.
- Spindle Hold button.
- Feed HOLD button.
- Feed RELEASE button.
- Turret position indicator.
- Turret position selector for indexing turret to the required position during setup operations in JOG mode.
- Turret Index ON push button.
- LED indication for
  - Reference point establishment
  - Single block mode
  - Optional stop
  - Dry run
  - Lubricant oil low level
Machine lamp ON/OFF button

Chip conveyor ON/OFF button

CNC control panel

- **Monitor** – it will indicate current status of the various machine parameters namely, X and Z position, mode in which machine is functioning at present, the part programme step in which presently running, spindle speed, feed rate, tool number, tool offset number, etc.

- Below the monitor there are soft keys (membrane or tactile keys) to select menus for different modes selected. The control panel consists of keys to communicate with CNC controller and keys/buttons/switches for controlling machine movements and functions.

- Communication with CNC controller is performed using soft keys below the monitor and right side of the monitor.

- On the right side of the monitor there is a keypad similar to typewriter keypad which is used for keying in part programs and editing them.

- Page UP, page down keys are provided.

### Demonstrate

- Procedure of running program in different modes.

**Steps**

**Reference Mode (Starting and Referencing a Machine)**

REF Mode is used for establishing the measuring system of the machine in X and Z axis immediately on switching ON the machine. No other activity is done using this mode.

**Step 1:** Before switching ON the machine ensure that power input stabilizer is switched ON and RESET.

**Step 2:** Switch ON the machine and wait for message to appear in monitor.

**Step 3:** Switch ON hydraulics (notice the noise generated due to hydraulics)

**Step 4:** Switch ON the machine lamp.

**Step 5:** Press RESET button.

**Step 6:** Press feed RELEASE push button.

**Step 7:** Check the turret position. If the turret is in the right hand top corner, select JOG mode. Manually move the slide pressing -X and -Z push buttons to bring it to middle of the stroke.

**Step 8:** If the turret is in the middle of the stroke the above step need not be performed.

**Step 9:** Select REF mode.

**Step 10:** Press +X button – the slide starts moving up, stops at the machine reference point and LED indication shows the reference point is established in Z direction.

**Step 11:** Press +Z button – the slide starts moving towards the right side, stops at the machine reference point and LED indication shows the reference point is established in Z direction.
JOG Mode (Manual) Operations
This mode is mainly provided in the CNC lathe only for setup operations like checking spindle rotation, moving slides for measuring tool offsets, indexing tool turret to bring the required tool in position during measuring tool offset, checking the functioning of coolant motor, conveyor and similar accessories and attachments.

1. Select JOG mode in mode selector switch.
3. Press coolant ON/OFF button to execute the function.
4. Press foot switch for clamping de-clamping of work piece in the chuck.
5. To index the tool turret, slides must be in reference position.
6. To index the tool turret to any required position, select the required turret position in the selector switch and press turret index button. Turret will move to the indexed position.

Edit Mode
Edit mode is used for keying in a new part program store it inside the CNC and to edit stored programs.

Procedure to keying in new part program is simple

1. Select EDIT mode.
2. Select PGM (program) in menu key below the monitor.
3. Select NEW in menu key below the monitor.
4. Press O using Alpha numeric key pad. O indicates a program.
5. Assign a number and key in the number for the program using alpha numeric key pad.
6. Press INSERT key in alpha numeric keypad.
7. On pressing INSERT key an empty program with the number keyed in is stored and it is ready for editing.
8. Use the alpha numeric key pad for keying in the program.
9. As and when it is keyed in, the program is stored by pressing INSERT button.

Procedure to select and edit a stored part program

1. Select EDIT mode.
2. Select PGM (program) in menu key below the monitor.
3. Select DIR (directory) in menu key below the monitor.
4. Search for the program to be used using UP or DOWN arrow key in alpha numeric key pad.
5. Press Select key from the menu keypad for editing the part program.
6. Check if the program number displayed on the monitor is correct.
7. Use alpha numeric keypad for keying the codes and alter the programme.

Auto Mode
Auto mode is used for production of work pieces continuously on auto cycles. During auto cycle run the tool offsets can be adjusted manually in the tool offset page on the monitor.

Procedure to select and run a stored part program

1. Select EDIT mode.
2. Select PGM (program) in menu key below the monitor.
3. Select DIR (directory) in menu key below the monitor.
4. Search for the program to be used using UP or DOWN arrow key in alpha numeric key pad.
5. Select PAGE DOWN key in alpha numeric key pad for bringing the program to AUTO mode run.
6. Check the program number displayed on the monitor for correctness.
7. Pick up the work piece, load it on the chuck, press foot switch for clamping & close the door.
8. Without chuck in clamp position machine will not auto cycle.
9. Press cycle start button for activating the cycle.
10. Do not open the door/ machine Guard till auto cycle is completed (look for patrol light indication for cycle completion).
11. Chuck will not open when the spindle is running.
12. Open the door, press foot switch for de-clamping the work piece.

Procedure to adjust tool offset (wear)
1. Check the dimension of work piece produced. Compare it with drawing dimensions. Calculate the value to be corrected and note down. Either plus or minus.
2. Identify the tool number for which correction has to be done.
3. Altering the dimension of the diameter is done by altering the value of wear offset in X axis for the relevant tool and length has to be adjusted in the Z axis for the relevant tool.
4. Check whether control system is in auto mode.
5. Press OFFSET soft key in the alpha numeric keypad.
6. Press WEAR in the menu keys.
7. Use UP and DOWN arrow keys in the alpha numeric keypad to locate the tool number for which correction has to be done.
8. Position the cursor in the correct axis.
9. Key in the value noted earlier using alpha numeric keypad along with plus or minus symbol.
10. Press + INPUT in the menu key.
11. Now the alterations are saved to run the auto cycle with corrections.
12. The altered settings will be applied in the next auto cycle.

Auto SBLK (Single Block) Mode
Auto SBLK mode is used for testing new part program by executing the part program block wise. Machine stops after completion of instruction in every block and waits for the operator to press the AUTO start button.
1. Select EDIT mode.
2. Select PGM (program) in menu key below the monitor.
3. Select DIR (directory) in menu key below the monitor.
4. Search for the program to be used using UP or DOWN arrow key in alpha numeric key pad.
5. Select PAGE DOWN key in alpha numeric key pad for bringing the program to AUTO mode run.
6. Check the program number displayed on the monitor for correctness.
7. Select SBLK mode.
8. Press cycle start button to run the machine in SBLK mode.
9. Press cycle start button after stoppage of machine in every block.
MDI (Manual Data Input) Mode
The MDI mode is used for internal software data, PLC (program logic controller) data, and electrical signals (IN / OUT status) by electronic maintenance personnel. Operator should not open these menus.

1. Select MDI mode in mode selector switch.
2. Use alpha numeric keypad for keying in any G/M codes and numbers.
3. As and when the keys are pressed they appear on the monitor. Check for the correctness.
4. After completing a block of instructions press EOB (End of Block) soft key in the alpha numeric keypad.
5. Press OUTPUT START button in the alpha numeric keypad for execution of this block.
6. Storing of this program is possible by pressing store soft key appearing in the menu soft key.

Tape Mode
TAPE mode is used to run the machine by feeding the program from an external device through RS 232C cables.

Activity
- Conduct a skill practice activity.
- Ask the students to assemble together.
- Explain the purpose and duration of the activity.
- Set guidelines pertaining to discipline and expected tasks.

<table>
<thead>
<tr>
<th>Skill Practice</th>
<th>Time</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run a part program in EDIT mode, JOG mode, AUTO mode and AUTO SBLK mode</td>
<td>4 hours</td>
<td>CNC lathe machine</td>
</tr>
</tbody>
</table>

Do
- Ask them to get practice the activity alone.
- Give them a part program
- Go around and make sure they are doing it properly.
• Summarize the main points.
• Ask participants if they have any doubts.
• Encourage them to ask questions.
• Answer their queries satisfactorily.
• Tell participants to complete the questions at the end of the unit.
• Ensure that every participant answer all the questions.
UNIT 5.4: G Codes and M Codes

Unit Objectives

At the end of this unit, you will be able to:
1. Understand G codes and their functions;
2. Understand M codes and their functions.

Resources to be Used

- Available objects such as white board, white board marker pens, duster, Participant manual.
- PC with LCD Projector or Flip Chart
- CNC lathe machine

Do

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

- To develop a program in a CNC lathe machine, codes are required to give commands. These codes are called G codes and M codes.
- G codes are important codes. They are also called preparatory codes and are commands in a CNC program. They begin with the letter G.
- The M codes are miscellaneous codes and are commands in a CNC program; they begin with the letter M.

Elaborate

G-Codes

G codes are specific general command indicating the machine tool what type of action to perform, such as:

Elaborate
• Rapid move (transport the tool through space to the place where it is needed for cutting; do this as quickly as possible)
• Controlled feed move in a straight line or arc
• Series of controlled feed moves that would result in a hole being bored, a work piece being cut to a specific dimension, or a profile or a shape added to the edge of a work piece.

Commonly used G-Codes for CNC Lathe Machines are as follows:

<table>
<thead>
<tr>
<th>Code: G00</th>
<th>Function</th>
<th>Code: G00</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>Rapid Positioning</td>
<td>G01</td>
<td>Linear Interpolation</td>
</tr>
<tr>
<td>02</td>
<td>Circular Interpolation CW</td>
<td>G03</td>
<td>Circular Interpolation CCW</td>
</tr>
<tr>
<td>04</td>
<td>Dwell</td>
<td>G07</td>
<td>Feed rate Sine Curve Control</td>
</tr>
<tr>
<td>10</td>
<td>Data Setting</td>
<td>G11</td>
<td>Data Setting Cancel</td>
</tr>
<tr>
<td>17</td>
<td>XY Plane Selection</td>
<td>G18</td>
<td>XZ Plane Selection</td>
</tr>
<tr>
<td>19</td>
<td>YZ Plane Selection</td>
<td>G20</td>
<td>Input in Inches</td>
</tr>
<tr>
<td>21</td>
<td>Input in Metric</td>
<td>G22</td>
<td>Stored Stroke Check ON</td>
</tr>
<tr>
<td>23</td>
<td>Stored Stroke Check OFF</td>
<td>G27</td>
<td>Reference Point Return Check</td>
</tr>
<tr>
<td>28</td>
<td>Automatic Zero Return</td>
<td>G29</td>
<td>Return from Zero Position</td>
</tr>
<tr>
<td>30</td>
<td>2nd Reference Point Return</td>
<td>G31</td>
<td>Skip Function</td>
</tr>
<tr>
<td>32</td>
<td>Thread Cutting</td>
<td>G36</td>
<td>Automatic Tool Compensation</td>
</tr>
<tr>
<td>40</td>
<td>Tool Compensation Cancel</td>
<td>G41</td>
<td>Tool Compensation Left</td>
</tr>
<tr>
<td>42</td>
<td>Tool Compensation Right</td>
<td>G46</td>
<td>Automatic Tool Compensation</td>
</tr>
<tr>
<td>50</td>
<td>Coordinate System Setting</td>
<td>G52</td>
<td>Local Coordinate System Setting</td>
</tr>
<tr>
<td>53</td>
<td>Machine Coordinate System Setting</td>
<td>G54</td>
<td>Work piece Coordinate Setting 1</td>
</tr>
<tr>
<td>55</td>
<td>Work piece Coordinate Setting 2</td>
<td>G56</td>
<td>Work piece Coordinate Setting 3</td>
</tr>
<tr>
<td>57</td>
<td>Work piece Coordinate Setting 4</td>
<td>G58</td>
<td>Work piece Coordinate Setting 5</td>
</tr>
<tr>
<td>59</td>
<td>Work piece Coordinate Setting 6</td>
<td>G61</td>
<td>Exact Stop Check Mode</td>
</tr>
<tr>
<td>62</td>
<td>Automatic Corner Override</td>
<td>G63</td>
<td>Tapping Mode</td>
</tr>
<tr>
<td>64</td>
<td>Cutting Mode</td>
<td>G65</td>
<td>User Simple Macro Call</td>
</tr>
<tr>
<td>66</td>
<td>User Modal Macro Call</td>
<td>G67</td>
<td>User Modal Macro Call Cancel</td>
</tr>
<tr>
<td>70</td>
<td>Finishing Cycle</td>
<td>G71</td>
<td>Turning Cycle</td>
</tr>
<tr>
<td>72</td>
<td>Facing Cycle</td>
<td>G73</td>
<td>Pattern Repeating Cycle</td>
</tr>
<tr>
<td>74</td>
<td>Drilling Cycle</td>
<td>G75</td>
<td>Grooving Cycle</td>
</tr>
<tr>
<td>76</td>
<td>Threading Cycle</td>
<td>G80</td>
<td>Canned Cycle Cancel</td>
</tr>
<tr>
<td>83</td>
<td>Face Drilling Cycle</td>
<td>G84</td>
<td>Face Tapping Cycle</td>
</tr>
<tr>
<td>85</td>
<td>Face Boring Cycle</td>
<td>G87</td>
<td>Side Drilling Cycle</td>
</tr>
<tr>
<td>88</td>
<td>Side Tapping Cycle</td>
<td>G89</td>
<td>Side Boring Cycle</td>
</tr>
<tr>
<td>90</td>
<td>Absolute Positioning</td>
<td>G91</td>
<td>Incremental Positioning</td>
</tr>
<tr>
<td>92</td>
<td>Threading Cycle</td>
<td>G94</td>
<td>Face Turning Cycle</td>
</tr>
<tr>
<td>96</td>
<td>Constant Surface Speed Control On</td>
<td>G97</td>
<td>Constant Surface Speed Control Off</td>
</tr>
</tbody>
</table>
M Codes

M Codes are used by the operator to turn on and off required functions of the machine.

Commonly used M-Codes for CNC Lathes

<table>
<thead>
<tr>
<th>Code: M</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>Program Stop</td>
</tr>
<tr>
<td>M01</td>
<td>Optional Program Stop</td>
</tr>
<tr>
<td>M02</td>
<td>Program End</td>
</tr>
<tr>
<td>M03</td>
<td>Spindle Clockwise</td>
</tr>
<tr>
<td>M04</td>
<td>Spindle Counter Clockwise</td>
</tr>
<tr>
<td>M05</td>
<td>Spindle Stop</td>
</tr>
<tr>
<td>M07</td>
<td>Coolant 1 On</td>
</tr>
<tr>
<td>M08</td>
<td>Coolant 2 On</td>
</tr>
<tr>
<td>M09</td>
<td>Coolant Off</td>
</tr>
<tr>
<td>M30</td>
<td>End Program, Return to Start</td>
</tr>
<tr>
<td>M98</td>
<td>Call Subprogram</td>
</tr>
</tbody>
</table>

General Vocabulary for CNC Lathe

<table>
<thead>
<tr>
<th>Vocabulary Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute Coordinates</td>
<td>A series of numerical positions that are calculated from a fixed point of origin.</td>
</tr>
<tr>
<td>Address</td>
<td>The letter used within a word that signals the essential function of the word.</td>
</tr>
<tr>
<td>Axes</td>
<td>An imaginary line that passes through the center of an object. Axes are used to measure the distances of objects in the Cartesian coordinate system.</td>
</tr>
<tr>
<td>Block</td>
<td>A single line of the part program that consists of words.</td>
</tr>
<tr>
<td>Blueprint</td>
<td>A design representing the dimensions of a specific work piece that is used to create the part program.</td>
</tr>
<tr>
<td>Cartesian Coordinate System</td>
<td>The numerical system that describes the location of an object by numerically expressing its distance from a fixed position along three linear axes.</td>
</tr>
<tr>
<td><strong>Computer Assisted Programming</strong></td>
<td>The use of computer software that facilitates the development of part programs. These software applications create an image of the work piece and develop the program code from information that the programmer puts in.</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Conversational Interface</strong></td>
<td>An interface that asks the user a series of questions and then translates the user’s answers into part program code.</td>
</tr>
<tr>
<td><strong>Cutter Offset</strong></td>
<td>A predetermined distance from the surface of the work piece that allows for the safe and rapid movement of the cutting tool between cutting operations.</td>
</tr>
<tr>
<td><strong>Dry Run</strong></td>
<td>A trial run of the part program without any parts or cutting fluids.</td>
</tr>
<tr>
<td><strong>Electronics Industries Association</strong></td>
<td>An organization that sets standards for technology industries.</td>
</tr>
<tr>
<td><strong>F code</strong></td>
<td>A word that determines the feed during a cutting operation.</td>
</tr>
<tr>
<td><strong>Feed</strong></td>
<td>The rate that the cutting tool travels along the surface of the work piece.</td>
</tr>
<tr>
<td><strong>G code</strong></td>
<td>A word that determines the type of operation performed on the machine.</td>
</tr>
<tr>
<td><strong>Incremental Coordinates</strong></td>
<td>A series of numerical positions that use the previous position as the point of origin.</td>
</tr>
<tr>
<td><strong>M code</strong></td>
<td>A word used to signal an action from a miscellaneous group of commands. M codes change cutting tools, turn on or turn off the coolant, spindle, or work piece clamps, etc.</td>
</tr>
<tr>
<td><strong>N code</strong></td>
<td>A word that acts as the name or title for a program block.</td>
</tr>
<tr>
<td><strong>Operator</strong></td>
<td>The person responsible for running the CNC machine on the shop floor.</td>
</tr>
<tr>
<td><strong>Part Program</strong></td>
<td>A series of numerical instructions used by a CNC machine to perform the necessary sequence of operations to machine a specific workpiece.</td>
</tr>
<tr>
<td><strong>Part Programmer</strong></td>
<td>The person responsible for the creation of a part program. The part programmer translates the workpiece design into program instructions for the CNC machine.</td>
</tr>
<tr>
<td><strong>Program Zero</strong></td>
<td>The position that acts as the origin for the part program of a particular work piece. This position is unique to each work piece design, and it is selected by the part programmer.</td>
</tr>
<tr>
<td><strong>S code</strong></td>
<td>A word that determines the speed during a cutting operation.</td>
</tr>
<tr>
<td><strong>Speed</strong></td>
<td>The rate at which the cutting edge of the tool moves past the work piece surface at the point of contact.</td>
</tr>
<tr>
<td><strong>T code</strong></td>
<td>A word that determines which specific cutting tool will be selected during a tool change.</td>
</tr>
<tr>
<td><strong>Toolchanger</strong></td>
<td>A device on a machining center that arranges multiple cutting tools in order and then positions these cutting tools for replacement.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Toolpath</td>
<td>A series of program blocks that describes the movements of a single cutting tool.</td>
</tr>
<tr>
<td>Turning Center</td>
<td>A lathe machine that is controlled by a computer running programs driven by numerical data. Sophisticated turning centers can also perform a variety of drilling and lathe operations.</td>
</tr>
<tr>
<td>Turret</td>
<td>The component of a lathe that holds a number of cutting tools. The turret rotates to place tools in the cutting position.</td>
</tr>
<tr>
<td>Word</td>
<td>The pairing of a letter address and a numerical value.</td>
</tr>
<tr>
<td>X code</td>
<td>A word that describes a specific position along the X-axis.</td>
</tr>
<tr>
<td>X-axis</td>
<td>The linear axis representing motions and positions that travel the longest distance parallel to the worktable.</td>
</tr>
<tr>
<td>Y code</td>
<td>A word that describes a specific position along the Y-axis.</td>
</tr>
<tr>
<td>Y-axis</td>
<td>The linear axis representing motions and positions that travel the shortest distance parallel to the worktable.</td>
</tr>
<tr>
<td>Z code</td>
<td>A word that describes a specific position along the Z-axis.</td>
</tr>
<tr>
<td>Z-axis</td>
<td>The linear axis that represents motions and positions perpendicular to the worktable. The Z-axis is always parallel to the spindle.</td>
</tr>
</tbody>
</table>

*Table 5.4.3: General Vocabulary FOR CNC Lathe*

**Do**
- Show them G codes and M codes chart.
- Ask about function of G codes and M codes from every trainee

**Notes for Facilitation**
- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
**UNIT 5.5: Part Program Development**

**Unit Objectives**

*At the end of this unit, you will be able to:*

1. Explain how a part program development works.

**Resources to be Used**

- Available objects such as white board, white board marker pens, duster, Participant manual.
- PC with LCD Projector or Flip Chart
- CNC lathe machine

**Do**

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

**Say**

- A program is very important for performing an operation on CNC Lathe Machine. It would not be wrong.
- A program acts as the lifeline of the operation. Without the program; the machine cannot turn the product accurately.
- The program has to be based on the sequence of operations planned. The program necessarily requires the input of tool offsets and tool numbers to be fed for the program to function completely to make the work piece as per requirement.

**Demonstrate**

Running a program - PROGRAM S.No: O0400

<table>
<thead>
<tr>
<th>PROGRAM S.No: O0400</th>
<th>Start of Facing Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>S.No : O0400</td>
<td>1st SET UP PROGRAM</td>
</tr>
<tr>
<td>G28U0.W0</td>
<td>Reference Point Return</td>
</tr>
<tr>
<td>N3</td>
<td>Sequence Number</td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>T0303</td>
<td>Tool no 3 with Offset no 3</td>
</tr>
<tr>
<td>G50S2000</td>
<td>Maximum R.P.M clamp at 2000</td>
</tr>
<tr>
<td>G96S150M4</td>
<td>Constant surface Speed with Direction of Rotation of Spindle Anti-clockwise at cutting speed 150m/min</td>
</tr>
<tr>
<td>G0Z50</td>
<td>Rapid Movement of tool in Z axis 50mm distance before work piece zero point.</td>
</tr>
<tr>
<td>M8</td>
<td>Coolant on</td>
</tr>
<tr>
<td>X52.0</td>
<td>Rapid Movement of tool in X axis 52mm Dia.</td>
</tr>
<tr>
<td>G0Z2.</td>
<td>Rapid Movement of tool in Z axis 2mm distance before work piece zero point.</td>
</tr>
</tbody>
</table>

**Facing and OD Turning Operation Starts**

| G94X0Z0.5F0.15 | Facing Cycle Starts with feed 0.15mm / revolution |
| Z0.1           | Tool moves in Z axis 0.1mm distance before work piece zero point. |
| Z0             | Tool moves in Z axis to work piece zero point. |
| G0X51.0Z2.0    | Rapid movement of tool in X to 51mm dia and 2mm distance in Z direction before work piece zero point. |
| G71U0.3R0.5    | Canned cycle for roughing starts with depth of cut 0.3 mm R is escaping amount. |
| G71P10Q2U0.2W0.05F0.15 | P is the start point of profile Q is end point of profile U&W finishing allowance in X and Z axis direction. |
| N10G01X42.5F0.15 | Linear movement of tool in X axis to 42.5 mm dia with feed 0.15mm/revolution. |
| G01Z-75.0      | Linear movements of tool in Z axis to 75mm distance after Work Piece zero point. |
| G01X48.5       | Linear movement of tool in X axis with 48.5mm dia. |
| N20G01Z-90.0   | Linear movements of tool in Z axis to 90 mm distance after work piece zero point. |
| G0Z10.         | Rapid movements of tool in Z direction to 10 mm distance before work piece zero point. |
| G0X100.Z100.M9 | Rapid movement of tool in X axis to 100mm dia and Z direction to 100mm distance before work piece zero point and coolant off. |
| M5             | Spindle Stop                     |
| G28U0W0        | Reference Point Return           |
| M1             | Optional Stop.                   |

**End of Facing and OD Turning Tool Program**

**Start of Centre Drill program**

<table>
<thead>
<tr>
<th>N4</th>
<th>Sequence No</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0404</td>
<td>Tool no 4 with Offset no 4</td>
</tr>
<tr>
<td>G97S1000M4</td>
<td>Constant surface Speed cancel and Spindle Rotation Anti-Clockwise with 1000rpm</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>----------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>G0X0Z10</td>
<td>Rapid Movement of X axis to Zero and Z axis to 10mm distance before Work Piece Zero Point.</td>
</tr>
<tr>
<td>G01Z2.F.5</td>
<td>Linear Movement of Z axis to 2mm distance before Work Piece Zero Point with feed 0.5 mm./revolution</td>
</tr>
<tr>
<td>G1Z-5.0F.02</td>
<td>Linear Movement of Z axis to 5mm distance after Work Piece Zero Point with feed 0.02 mm./revolution</td>
</tr>
<tr>
<td>G01Z5.0F.05</td>
<td>Linear Movement of Z axis to 5 mm distance before Work Piece zero Point with feed 0.5 mm./revolution</td>
</tr>
<tr>
<td>G0Z20.</td>
<td>Rapid Movement of Z axis to 20mm distance before Work Piece Zero Point.</td>
</tr>
<tr>
<td>M5</td>
<td>Spindle Stop.</td>
</tr>
<tr>
<td>M9</td>
<td>Coolant Off</td>
</tr>
<tr>
<td>G28U0.W0.</td>
<td>Return to Reference Point.</td>
</tr>
<tr>
<td></td>
<td><strong>End of Central Drill Program</strong></td>
</tr>
<tr>
<td>N7</td>
<td>Sequence Number</td>
</tr>
<tr>
<td>T0707</td>
<td>Tool no 7 with offset No 7.</td>
</tr>
<tr>
<td>(Drill 20.0MM)</td>
<td></td>
</tr>
<tr>
<td>G97S350M04</td>
<td>Constant surface Speed cancel with Spindle Rotation Anti- Clockwise at 350r.p.m.</td>
</tr>
<tr>
<td>G0X0.Z5.M8</td>
<td>Rapid Movement of X axis to zero and Z axis to 5mm distance before Work Piece Zero point and coolant Off.</td>
</tr>
<tr>
<td>G1Z1.F.1</td>
<td>Linear Movement of Z axis to 1mm distance before Work Piece Zero Point with feed 0.1mm/Revolution.</td>
</tr>
<tr>
<td>G1Z-41.0.F.02</td>
<td>Linear Movement of Z axis to 41mm distance after Work Piece Zero Point with feed 0.02 mm/Revolution.</td>
</tr>
<tr>
<td>G1Z2.F.8</td>
<td>Linear Movement of Z axis to 2mm distance before Work Piece Zero Point with feed 0.8mm/Revolution.</td>
</tr>
<tr>
<td>G0Z20.M5</td>
<td>Rapid Movement of Z axis to 20mm distance before Work Piece Zero Point and Spindle Stop.</td>
</tr>
<tr>
<td>M9</td>
<td>Coolant Stop.</td>
</tr>
<tr>
<td>G28U0.W0.</td>
<td>Return to Reference Point.</td>
</tr>
<tr>
<td>M1</td>
<td>Optional Stop.</td>
</tr>
<tr>
<td></td>
<td><strong>End of Drilling Program</strong></td>
</tr>
<tr>
<td>N2</td>
<td>Sequence number</td>
</tr>
<tr>
<td>T0202 (BORING)</td>
<td>Tool no 2 with offset no 2.</td>
</tr>
<tr>
<td>G5052000</td>
<td>Maximum R.P.M Clamp at 2000</td>
</tr>
<tr>
<td>G96S150M3</td>
<td>Constant surface Speed with Spindle Rotation Clockwise &amp; cutting speed 150m/min.</td>
</tr>
<tr>
<td>G0Z50</td>
<td>Rapid Movement of Z axis to 50mm distance before Work Piece Zero Point.</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>----------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>M8</td>
<td>Coolant On</td>
</tr>
<tr>
<td>G0X19.5</td>
<td>Rapid Movement of X axis to 19.5mm Diameter.</td>
</tr>
<tr>
<td>Z2.0</td>
<td>Rapid Movement of Z axis to 2mm distance before Work Piece Zero Point.</td>
</tr>
<tr>
<td>G90X20.5Z-26.95F0.1</td>
<td>Turning Cycle Starts with First Cut at 20.5mm dia and feed 0.1mm/Revolution.</td>
</tr>
<tr>
<td>X21.0</td>
<td>2nd cut at 21mm dia</td>
</tr>
<tr>
<td>X21.5</td>
<td>3rd cut at 21.5mm dia</td>
</tr>
<tr>
<td>X22.0</td>
<td>4th cut at 22.0mm dia</td>
</tr>
<tr>
<td>X22.5</td>
<td>5th cut at 22.5mm dia</td>
</tr>
<tr>
<td>X23.0</td>
<td>6th cut at 23 mm dia</td>
</tr>
<tr>
<td>X23.5</td>
<td>7th cut at 23.5mm dia</td>
</tr>
<tr>
<td>X24.0</td>
<td>8th cut at 24 mm dia</td>
</tr>
<tr>
<td>X24.5</td>
<td>9th cut at 24.5mm dia</td>
</tr>
<tr>
<td>X25.0</td>
<td>10th cut at 25 mm dia</td>
</tr>
<tr>
<td>X25.5</td>
<td>11th cut at 25.5mm dia</td>
</tr>
<tr>
<td>X26.0</td>
<td>12th cut at 26 mm dia</td>
</tr>
<tr>
<td>X26.5</td>
<td>13th cut at 26.5mm dia</td>
</tr>
<tr>
<td>X27.0</td>
<td>14th cut at 27mm dia</td>
</tr>
<tr>
<td>X27.5</td>
<td>15th cut at 27.5mm dia</td>
</tr>
<tr>
<td>X28.0</td>
<td>16th cut at 28mm dia</td>
</tr>
<tr>
<td>X28.5</td>
<td>17th cut at 28.5mm dia</td>
</tr>
<tr>
<td>X29.0</td>
<td>18th cut at 29mm dia</td>
</tr>
<tr>
<td>X29.5</td>
<td>19th cut at 29.5mm dia</td>
</tr>
<tr>
<td>X30.0</td>
<td>20th cut at 30.0mm dia</td>
</tr>
<tr>
<td>X30.5</td>
<td>21st cut at 30.5mm dia</td>
</tr>
<tr>
<td>G0X34.6</td>
<td>Rapid Movement of X axis to 34.6mm dia.</td>
</tr>
<tr>
<td>G1Z0.1F0.1</td>
<td>Linear Movement of Z axis to 0.1mm distance before Work Piece Zero point with 0.1mm/Revolution.</td>
</tr>
<tr>
<td>G1X31.0C1.8F0.1</td>
<td>Linear Movement of X axis of 31 mm dia with chamfer 1.8mm and Feed 0.1mm/Revolution.</td>
</tr>
<tr>
<td>G1Z-27.0</td>
<td>Linear movement of Z axis to 27 mm distance after Work Piece Zero Point.</td>
</tr>
<tr>
<td>G1X20.0C1.0</td>
<td>Linear movement of X axis to 20mm distance with chamfer 1.0mm.</td>
</tr>
<tr>
<td>G1Z-28.5</td>
<td>Linear movement of Z axis to 28.5mm distance after Work Piece Zero Point.</td>
</tr>
<tr>
<td>G1U-0.2F0.1</td>
<td>Linear movement of X axis to 0.2mm downwards with feed 0.1mm/Revolution.</td>
</tr>
<tr>
<td>G0Z10.M9</td>
<td>Rapid Movement of Z axis to 10 mm distance before Work Piece Zero point and coolant off.</td>
</tr>
<tr>
<td>M5</td>
<td>Spindle Stop.</td>
</tr>
<tr>
<td>Command</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------</td>
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</tr>
<tr>
<td>G28U0W0</td>
<td>Return to Reference Point.</td>
</tr>
<tr>
<td>M30</td>
<td>Program stop and rewind – Change of Side of Workpiece.</td>
</tr>
<tr>
<td>S.No : 00401</td>
<td>2nd SETUP PROGRAM</td>
</tr>
<tr>
<td>G28U0.W0</td>
<td>Return to Reference Point</td>
</tr>
<tr>
<td>N3</td>
<td>Sequence number</td>
</tr>
<tr>
<td>T0303</td>
<td>Tool no 3. With offset no. 3</td>
</tr>
<tr>
<td>G50S2000</td>
<td>Maximum R.P.M clamp at 2000</td>
</tr>
<tr>
<td>G96S150M4</td>
<td>Constant surface Speed and Spindle Rotation Anti Clockwise with cutting speed 150m/min.</td>
</tr>
<tr>
<td>G0Z50</td>
<td>Rapid Movement of Z axis to 50 mm distance before Work Piece Zero Point.</td>
</tr>
<tr>
<td>M8</td>
<td>Coolant On</td>
</tr>
<tr>
<td>X52.0</td>
<td>Tool Moves in X axis to 52mm dia.</td>
</tr>
<tr>
<td>G0Z2</td>
<td>Rapid Movement of Z axis to 2 mm distance before Work Piece Zero Point.</td>
</tr>
<tr>
<td>G94X0Z0.5F0.15</td>
<td>Facing Cycle starts with feed 0.15mm /rev and Z moves to 0.5mm before Work Piece Zero Point.</td>
</tr>
<tr>
<td>Z0.1</td>
<td>Tool moves in Z axis to 0.1mm distance before Work Piece Zero Point.</td>
</tr>
<tr>
<td>G0X51.0Z0.5</td>
<td>Rapid Movement of X axis to 51mm dia and Z axis to 0.5mm before Work Piece Zero Point.</td>
</tr>
<tr>
<td>G71U0.8R0.5</td>
<td>Canned Cycle for Roughing starts with depth of cut 0.8mm Radius is escaping amount.</td>
</tr>
<tr>
<td>G71P10Q20U0.2W0.0SF0.15</td>
<td>P is start point Q is end point of profile U&amp;W finishing allowance in X and Z axis direction.</td>
</tr>
<tr>
<td>N10G01X28.0F0.15</td>
<td>Linear Movement of tool in x axis to dia 28mm with feed 0.15mm/Revolution.</td>
</tr>
<tr>
<td>G01X38.0Z-30.0</td>
<td>Taper Movement of tool in X and Z axis.</td>
</tr>
<tr>
<td>G01Z-80.0</td>
<td>Linear movement of Z axis to 80 mm from Work Piece Zero point.</td>
</tr>
<tr>
<td>G01X48.0</td>
<td>Linear Movement of X axis to 48mm dia.</td>
</tr>
<tr>
<td>N20G01Z-92.0</td>
<td>Linear Movement of Z axis to 92mm from Work Piece Zero point.</td>
</tr>
<tr>
<td>G0Z10</td>
<td>Retract of tool in z axis to 10mm before Work Piece Zero point.</td>
</tr>
<tr>
<td>X30.0</td>
<td>Rapid movement in X axis to dia 30mm.</td>
</tr>
<tr>
<td>G0Z2</td>
<td>Rapid movement in Z axis to 2mm before Work Piece Zero point.</td>
</tr>
<tr>
<td>G94X0Z0F0.15</td>
<td>Facing Cycle Starts with feed 0.15mm/Revolution.</td>
</tr>
<tr>
<td>G1X27.5F1.0</td>
<td>Tool Moves in X axis to dia 27.5 mm with feed 1.0mm/ Revolution.</td>
</tr>
<tr>
<td>Z0.2</td>
<td>Tool Moves in Z axis to 0.2 mm before Work Piece Zero point.</td>
</tr>
<tr>
<td>G01Z0F0.2</td>
<td>Linear movement of Z axis to zero point of Work Piece with feed 0.2mm/ Revolution</td>
</tr>
<tr>
<td>G01X38.0Z-30.0F0.15</td>
<td>Taper movement of X and Z axis with feed 0.15mm/ Revolution</td>
</tr>
<tr>
<td>Command</td>
<td>Description</td>
</tr>
<tr>
<td>-----------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>G01Z-80.0</td>
<td>Linear movement of Z axis to 80mm from Work Piece Zero point.</td>
</tr>
<tr>
<td>G01X47.5C1.0</td>
<td>Tool moves in X axis to dia. 47.5 mm with chamfer C=1mm.</td>
</tr>
<tr>
<td>G01Z-95.0</td>
<td>Linear movement of Z axis to 95mm from Work Piece Zero point.</td>
</tr>
<tr>
<td>G0U5.0</td>
<td>Rapid incremental of 5mm in X axis. (U = used for incremental value).</td>
</tr>
<tr>
<td>G0X100.Z100.M9</td>
<td>Rapid movement of tool in X axis to dia 100mm and in Z axis to 100mm before Work Piece Zero point.</td>
</tr>
<tr>
<td>M5</td>
<td>Spindle Stop</td>
</tr>
<tr>
<td>G28U0W0</td>
<td>Return to Reference Point.</td>
</tr>
<tr>
<td>M1</td>
<td>Optional Stop</td>
</tr>
<tr>
<td></td>
<td><strong>End of Facing, O.D. Turning and Taper Turning Program.</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Start of Center Drilling Program</strong></td>
</tr>
<tr>
<td>G28U0.W0.</td>
<td>Return to Reference Point.</td>
</tr>
<tr>
<td>N4</td>
<td>Sequence No</td>
</tr>
<tr>
<td>T0404</td>
<td>Tool no 4 with offset no 4.</td>
</tr>
<tr>
<td>CENTER DRILL</td>
<td></td>
</tr>
<tr>
<td>G97S500M04</td>
<td>Constant surface Speed cancel and Spindle Rotation Anti-Clockwise at 500 rpm</td>
</tr>
<tr>
<td>G0X0.Z5.M8</td>
<td>Rapid Movement of X axis to zero point and Z axis to 5mm before Work Piece Zero point and Coolant On</td>
</tr>
<tr>
<td>G1Z1.F.1</td>
<td>Linear Movement of Z axis to 1 mm before Work Piece Zero Point with feed 0.1mm/Revolution.</td>
</tr>
<tr>
<td>G1Z-5.0F0.02</td>
<td>Linear Movement of Z axis to 5mm from Work Piece Zero point with feed 0.02mm/Revolution.</td>
</tr>
<tr>
<td>G1Z2.8</td>
<td>Retract of drill in Z axis to 2mm before Work Piece Zero point with feed 0.8mm/Revolution.</td>
</tr>
<tr>
<td>G0Z20.M5</td>
<td>Rapid Movement in Z axis to 20 mm before Work Piece Zero point and Spindle Stop.</td>
</tr>
<tr>
<td>M9</td>
<td>Coolant off</td>
</tr>
<tr>
<td>G28U0.W0</td>
<td>Return to reference point.</td>
</tr>
<tr>
<td>M1</td>
<td>Optional stop</td>
</tr>
<tr>
<td></td>
<td><strong>End of Center Drilling Program.</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Program stop and rewind. – Change of Side of Workpiece.</strong></td>
</tr>
<tr>
<td>S.No : 00402</td>
<td>3rd SETUP PROGRAM</td>
</tr>
<tr>
<td></td>
<td><strong>Start of OD Turning Tool Program</strong></td>
</tr>
<tr>
<td>G28U0.W0.</td>
<td>Return to Reference Point.</td>
</tr>
<tr>
<td>N3</td>
<td>Sequence Number</td>
</tr>
<tr>
<td>T0303</td>
<td>Tool number 3 with offset number 3.</td>
</tr>
<tr>
<td>G5 052000</td>
<td>Maximum R.P.M clamp at 2000</td>
</tr>
<tr>
<td>G96S150M4</td>
<td>Constant surface Speed and rotation of spindle anti clock wise with cutting speed 150m/min.</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>-------------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>G0Z50.</td>
<td>Rapid movements of Z axis 50mm distance before work piece zero point.</td>
</tr>
<tr>
<td>M8</td>
<td>Coolant ON.</td>
</tr>
<tr>
<td>X51.0</td>
<td>Rapid movement of X axis to 51mm dia.</td>
</tr>
<tr>
<td>G0Z2.</td>
<td>Rapid movements in Z axis 2 mm distance before work piece zero point.</td>
</tr>
<tr>
<td>G94X28.0Z0F0.15</td>
<td>Facing cycle</td>
</tr>
<tr>
<td>G0Z2.0</td>
<td>Rapid movements in Z axis to 2mm distance before work piece Zero point.</td>
</tr>
<tr>
<td>X36.0</td>
<td>Rapid movement in X axis to 36 mm dia</td>
</tr>
<tr>
<td>G01Z0.1F0.2</td>
<td>Linear movement in Z Axis to 0.1mm distance before work piece zero point with feed 0.2 mm/revolution</td>
</tr>
<tr>
<td>G01X38.0C1.0F0.15</td>
<td>Linear movement in X Axis to 38mm dia with chamfer 1 mm with feed 0.15mm/revolution.</td>
</tr>
<tr>
<td>G01Z-50.0</td>
<td>Linear movements in Z Axis to 50mm distance after work piece zero point.</td>
</tr>
<tr>
<td>G01X42.0C1.5</td>
<td>Linear movement in X Axis to 42mm dia with chamfer 1.5 Mm</td>
</tr>
<tr>
<td>G01Z-75.0</td>
<td>Linear movements in Z Axis to 75mm distance after work piece zero point.</td>
</tr>
<tr>
<td>G01X48.0C1.2</td>
<td>Linear movement in X Axis to 48mm dia with chamfer 1.2mm</td>
</tr>
<tr>
<td>G01Z-77.0</td>
<td>Linear movement in Z Axis to 77mm after work piece zero point.</td>
</tr>
<tr>
<td>G0U5.0</td>
<td>Retract of tool 5mm in X axis</td>
</tr>
<tr>
<td>G0X100.Z100.M9</td>
<td>Rapid movement of X and Z axis to 100mm each before work piece zero point &amp; coolant OFF</td>
</tr>
<tr>
<td>M5</td>
<td>Spindle stop.</td>
</tr>
<tr>
<td>G28U0W0</td>
<td>Return to reference point.</td>
</tr>
<tr>
<td>M1</td>
<td>Optional Stop</td>
</tr>
</tbody>
</table>

**End of OD turning tool program**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>N7</td>
<td>Start of OD Grooving program</td>
</tr>
<tr>
<td>G0T0707</td>
<td>Tool number 7 with offset number 7</td>
</tr>
<tr>
<td>G50S1200</td>
<td>Maximum R. P. M. clamp at 1200</td>
</tr>
<tr>
<td>G97S5000M3</td>
<td>Constant surface Speed cancel with Spindle Rotation Clockwise at 500 rpm</td>
</tr>
<tr>
<td>G0Z50.</td>
<td>Rapid Movement in Z axis to 50 mm distance before Work Piece Zero point.</td>
</tr>
<tr>
<td>M8</td>
<td>Coolant ON.</td>
</tr>
<tr>
<td>X49.0</td>
<td>Rapid Movement of X axis to 49 mm dia.</td>
</tr>
<tr>
<td>G0Z2.</td>
<td>Rapid Movement of Z axis to 2mm distance before Work Piece Zero point.</td>
</tr>
<tr>
<td>G1Z-75.0F2.0</td>
<td>Linear Movement of Z axis to 75mm distance with feed 2.0 mm/Revolution.</td>
</tr>
<tr>
<td>G1X48.2F0.5</td>
<td>Linear Movement of X axis to 48.2 mm dia with feed 0.5 mm/Revolution.</td>
</tr>
<tr>
<td>Command</td>
<td>Description</td>
</tr>
<tr>
<td>-----------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>X40.0F0.015</td>
<td>Linear Movement of X axis to 40mm dia with feed 0.015 mm/Revolution.</td>
</tr>
<tr>
<td>G4X0.5</td>
<td>Dwell Time of 0.5 second</td>
</tr>
<tr>
<td>G1X49.0F1.0</td>
<td>Linear Movement of X axis to 49mm dia with feed 1.0 mm/Revolution.</td>
</tr>
<tr>
<td>G0X60.0</td>
<td>Rapid Movement of X axis to 60 mm Dia.</td>
</tr>
<tr>
<td>G0Z50.M9</td>
<td>Rapid Movement of Z axis to 50 mm distance before Work Piece Zero point and coolant Off.</td>
</tr>
<tr>
<td>M5</td>
<td>Spindle stop</td>
</tr>
<tr>
<td>G0G28U0W0</td>
<td>Return to Reference point</td>
</tr>
<tr>
<td>M1</td>
<td>Optional Stop</td>
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</table>

**End of O.D. Grooving program.**

**START OF BORING TOOL PROGRAM**

<table>
<thead>
<tr>
<th>Command</th>
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<tbody>
<tr>
<td>N5</td>
<td>Sequence number</td>
</tr>
<tr>
<td>T0505</td>
<td>Tool number 5 with offset number 5</td>
</tr>
<tr>
<td>(BORING)</td>
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<tr>
<td>G50S2000</td>
<td>Maximum R.P.M. clamp at 2000</td>
</tr>
<tr>
<td>G96S150M4</td>
<td>Constant surface Speed With Spindle Rotation Anti-Clockwise&amp; cutting speed 150m/min.</td>
</tr>
<tr>
<td>G0Z50.</td>
<td>Rapid Movement of Z axis to 50mm distance before Work Piece Zero point</td>
</tr>
<tr>
<td>M8</td>
<td>Coolant On.</td>
</tr>
<tr>
<td>G0X34.0</td>
<td>Rapid Movement of X axis to 34 mm dia</td>
</tr>
<tr>
<td>Z2.0</td>
<td>Rapid Movement of Z axis to 2.0 mm distance before Work Piece Zero point</td>
</tr>
<tr>
<td>G1Z0.1F0.1</td>
<td>Linear Movement of Z axis to 0.1mm before Work Piece Zero point.</td>
</tr>
<tr>
<td>G1X31.5C1.0F0.1</td>
<td>Linear Movement of X axis to 31.5mm dia with chamfer 1mm with feed 0.1 mm/Revolution.</td>
</tr>
<tr>
<td>G1Z-27.0</td>
<td>Linear Movement of Z axis to 27 mm distance after Work Piece Zero point</td>
</tr>
<tr>
<td>G1X20.5C2.0</td>
<td>Linear Movement of X axis to 20.5mm dia with chamfer 2mm</td>
</tr>
<tr>
<td>G1Z-30.0</td>
<td>Linear Movement of Z axis to 30mm distance after Work Piece Zero point</td>
</tr>
<tr>
<td>G1U-0.2F0.1</td>
<td>Retract of Tool 0.2mm down in X axis with feed 0.1 mm/Revolution.</td>
</tr>
<tr>
<td>G0Z10.M9</td>
<td>Rapid Movement of Z axis to 10mm distance before Work Piece Zero point and coolant Off.</td>
</tr>
<tr>
<td>M5</td>
<td>Spindle Stop.</td>
</tr>
<tr>
<td>M1</td>
<td>Optional Stop.</td>
</tr>
</tbody>
</table>

**END OF BORING TOOL PROGRAM**

**START OF INTERNAL GROOVE TOOL PROGRAM**

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
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<tbody>
<tr>
<td>G28U0W0</td>
<td>Return to Reference point</td>
</tr>
<tr>
<td>N6</td>
<td>Sequence number</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>G0T0606</td>
<td>Tool Number 6 with Offset Number 6</td>
</tr>
<tr>
<td>G50S1200</td>
<td>Maximum R.P.M Clamp at 1200</td>
</tr>
<tr>
<td>G97S500M3</td>
<td>Constant surface Speed cancel with Spindle Rotation Clockwise 500 rpm</td>
</tr>
<tr>
<td>G0Z50</td>
<td>Rapid Movement of Z axis to 50mm distance before Work Piece Zero point.</td>
</tr>
<tr>
<td>M8</td>
<td>Coolant ON</td>
</tr>
<tr>
<td>X20.0</td>
<td>Rapid Movement of X axis to 20mm dia</td>
</tr>
<tr>
<td>G0Z2</td>
<td>Rapid Movement of Z axis to 2mm distance before Work Piece Zero point.</td>
</tr>
<tr>
<td>G1Z-27.0F2.0</td>
<td>Linear Movement of Z axis to 27mm distance after Work Piece Zero point.</td>
</tr>
<tr>
<td>G1X20.0F1.0</td>
<td>Linear Movement of X axis to 20 mm dia with feed 1mm/Revolution.</td>
</tr>
<tr>
<td>G0Z50.0</td>
<td>Rapid Movement of Z axis to 50mm distance before Work Piece Zero point.</td>
</tr>
<tr>
<td>G0G28U0W0M5</td>
<td>Return to Reference Point and Spindle Stop</td>
</tr>
<tr>
<td>M1</td>
<td>Optional Stop</td>
</tr>
<tr>
<td></td>
<td>END OF INTERNAL GROOVE TOOL PROGRAM</td>
</tr>
<tr>
<td></td>
<td>START OF EXTERNAL THREADING TOOL PROGRAM</td>
</tr>
<tr>
<td>N1</td>
<td>Sequence number</td>
</tr>
<tr>
<td>T0101</td>
<td>Tool number 1 Offset number 1</td>
</tr>
<tr>
<td>G97S1500M4</td>
<td>Constant surface Speed cancel with Spindle Rotation Anti- Clockwise at 1500 rpm</td>
</tr>
<tr>
<td>G0Z50</td>
<td>Rapid Movement of Z axis to 50mm distance before Work Piece Zero Point.</td>
</tr>
<tr>
<td>M8</td>
<td>Coolant ON</td>
</tr>
<tr>
<td>G0X43.0</td>
<td>Rapid Movement of X axis to 43mm dia</td>
</tr>
<tr>
<td>G01Z5.0F0.5</td>
<td>Linear Movement of Z axis to 5.0 mm distance before Work Piece Zero point with feed 0.5mm/Revolution.</td>
</tr>
<tr>
<td>G1Z-45.0F0.5</td>
<td>Linear Movement of Z axis to 45 mm distance after Work Piece Zero point with feed 0.5mm/Revolution.</td>
</tr>
<tr>
<td></td>
<td>THREADING CYCLE STARTS</td>
</tr>
<tr>
<td>G92X41.5Z-73.5F1.5</td>
<td>Threading Cycle Starts with pitch 1.5mm and First pass at 41.5mm dia.</td>
</tr>
<tr>
<td>X41.0</td>
<td>2nd pass at 41mm dia</td>
</tr>
<tr>
<td>X40.9</td>
<td>3rd pass at 40.9mm dia</td>
</tr>
<tr>
<td>X40.8</td>
<td>4th pass at 40.8mm dia</td>
</tr>
<tr>
<td>X40.7</td>
<td>5th pass at 40.7mm dia</td>
</tr>
<tr>
<td>X40.6</td>
<td>6th pass at 40.6mm dia</td>
</tr>
<tr>
<td>Symbol</td>
<td>Description</td>
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</tr>
<tr>
<td>X40.55</td>
<td>7th pass at 40.55mm dia</td>
</tr>
<tr>
<td>X40.52</td>
<td>8th pass at 40.52mm dia</td>
</tr>
<tr>
<td>X40.5</td>
<td>9th pass at 40.5mm dia</td>
</tr>
<tr>
<td>X40.5</td>
<td>Idle pass at 40.5mm dia</td>
</tr>
<tr>
<td>G0Z10.M9</td>
<td>Rapid Movement of Z axis to 10mm distance before Work Piece Zero point and Coolant Off</td>
</tr>
<tr>
<td>M5</td>
<td>Spindle Stop</td>
</tr>
<tr>
<td>G28U0W0</td>
<td>Return to Reference Point</td>
</tr>
<tr>
<td>M1</td>
<td>Optional Stop</td>
</tr>
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</table>

**END OF EXTERNAL THREADING TOOL PROGRAM**

**START OF INTERNAL THREADING TOOL PROGRAM**

<table>
<thead>
<tr>
<th>Symbol</th>
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<tr>
<td>N8</td>
<td>Sequence number</td>
</tr>
<tr>
<td>T0808</td>
<td>Tool number 8 with offset number 8</td>
</tr>
<tr>
<td>G97S2000M4</td>
<td>Constant surface Speed cancel with Spindle Rotation Anti- Clockwise at 2000 rpm</td>
</tr>
<tr>
<td>G0Z50</td>
<td>Rapid Movement of Z axis to 50 mm distance before Work Piece Zero Point.</td>
</tr>
<tr>
<td>M8</td>
<td>Coolant ON</td>
</tr>
<tr>
<td>G0X31.0</td>
<td>Rapid Movement of X axis to 31mm dia</td>
</tr>
<tr>
<td>Z5.0</td>
<td>Rapid Movement of Z axis to 5mm distance before Work Piece Zero point.</td>
</tr>
<tr>
<td>G92X32.0Z-26.5F1.5</td>
<td>Threading Cycle Starts with pitch1.5 and first pass at 32 mm dia</td>
</tr>
<tr>
<td>X32.5</td>
<td>2nd pass at 32.5 mm dia</td>
</tr>
<tr>
<td>X32.6</td>
<td>3rd pass at 32.6 mm dia</td>
</tr>
<tr>
<td>X32.7</td>
<td>4th pass at 32.7 mm dia</td>
</tr>
<tr>
<td>X32.8</td>
<td>5th pass at 32.8 mm dia</td>
</tr>
<tr>
<td>X32.9</td>
<td>6th pass at 32.9mm dia</td>
</tr>
<tr>
<td>X32.95</td>
<td>7th pass at 32.95 mm dia</td>
</tr>
<tr>
<td>X32.98</td>
<td>8th pass at 32.98 mm dia</td>
</tr>
<tr>
<td>X33.0</td>
<td>9th pass at 33.0mm dia</td>
</tr>
<tr>
<td>X33.0</td>
<td>Idle pass at 33.0mm dia</td>
</tr>
<tr>
<td>G0Z10.M9</td>
<td>Rapid Movement of Z axis to 10mm distance before Work Piece Zero point and Coolant OFF.</td>
</tr>
<tr>
<td>M5</td>
<td>Spindle Stop</td>
</tr>
<tr>
<td>G28U0W0</td>
<td>Return to Reference point</td>
</tr>
<tr>
<td>M1</td>
<td>Optional stop</td>
</tr>
</tbody>
</table>

**END OF INTERNAL THREADING TOOL PROGRAM**

**START OF PARTING TOOL PROGRAM**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>N7</td>
<td>Sequence number</td>
</tr>
<tr>
<td>G0T0707</td>
<td>Tool number 7 with Offset number 7</td>
</tr>
</tbody>
</table>
(PARTING)

G50S1200  Maximum R.P.M clamp at 1200

G97S500M3  Constant surface Speed cancel with Spindle Rotation Clockwise at 500 rpm

G0Z50.  Rapid Movement of Z axis to 50mm distance before Work Piece Zero point.

M8  Coolant ON

X39.0  Rapid Movement of X axis to 39mm dia.

G0Z2.  Rapid Movement of Z axis to 2mm distance before Work Piece Zero point.

G1Z-15.0F2.0  Linear Movement of Z axis to 15mm distance after Work Piece Zero point with feed 2 mm/Revolution.

G1X38.0F0.1  Linear Movement of X axis to 38mm dia with feed 0.1mm/ Revolution.

G4X0.5  Dwell time for 0.5 second.

G1X39.0F1.0  Linear Movement of X axis to 39mm dia with feed 1mm/ Revolution.

G0X60.0  Rapid movement of X axis to 60mm dia

G0Z50.M9  Rapid movement of Z axis to 50mm distance before Work Piece Zero point and Coolant OFF

G0G28U0W0M5  Return to Reference point and Spindle Stop

M30  End of program & rewind

END OF PARTING TOOL PROGRAM

END OF ALL PROGRAMS

---

**Activity**

- Conduct a skill practice activity.
- Ask the students to assemble together.
- Explain the purpose and duration of the activity.
- Set guidelines pertaining to discipline and expected tasks.

<table>
<thead>
<tr>
<th>Skill Practice</th>
<th>Time</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Write a parting tool program for drilling and facing</td>
<td>4 hours</td>
<td>CNC lathe machine</td>
</tr>
</tbody>
</table>
**Do**

- Divide the class into pairs.
- Go around and make sure they are doing it properly.

**Notes for Facilitation**

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
At the end of this unit, you will be able to:

1. Choose the appropriate throwaway insert tools.

**Unit Objectives**

**Resources to be Used**

- Available objects such as white board, white board marker pens, duster, Participant manual.
- PC with LCD Projector or Flip Chart
- CNC lathe machine, throw away tools

**Do**

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

**Say**

- Throw away insert tools are turning operation tools. They are considered a very important input for quality as well as efficiency of turning apart from the purpose/shape of turning required.
- The shape of tools, geometry and use depends upon material from which they are made, following basic types of tools are used for turning operations:
  1. High speed steel tools.
  2. Tungsten carbide tools
  3. Ceramic tools
  4. Diamond tools
- The selection of perfect type of throw away insert tool helps us to improve the quality of the finished product.
- The throw able bits are available in:
  1. Tungsten carbide bits
2. Titanium nitride coated tungsten carbide bits
3. Ceramic bits.

- For most of the operations tungsten carbide tool bits are preferred tooling material. For harder materials you need to use Titanium nitride coated tungsten carbide bits because the normal bits find it difficult to machine and ceramic bits are used for hardened material turning.
- Throw able bits that cannot be reground and reused. Thus, once the edge wears out or breaks the only option is to replace the same.

**Do**

- Show the throw away tools to trainees.
- Show the throw able bits to trainees.

**Notes for Facilitation**

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
UNIT 5.7: Mounting of Tool Holders on Turret

Unit Objectives

At the end of this unit, you will be able to:

1. Explain features of tool turret with regard to mounting of various tools, external tool holders etc.;

Resources to be Used

• Available objects such as white board, white board marker pens, duster, Participant manual.
• PC with LCD Projector or Flip Chart
• CNC lathe machine

Do

• Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

• Turret is a freely indexed movable wheel where different type of tooling can be fixed and on revolving the turret; the required type of tool comes into operation.
• Turret wheel circumference is divided in such a way that after indexing each tool will exactly realign itself matching the center axis of the lathe machine.
• Turret does not recognize the difference between the tool tip height with respect to its center while setting the tools on Turret the operator must take utmost care. It is his work to ensure that the cutting tip of each tool perfectly matches the center axis of the lathe.
• The setting has to be done in such a way that irrespective of the tool being on turret it comes to the point of operation. The setting must be done specifically for this operation and this tool.
• As an operator, you have to work with utmost care and caution.
Do

- Show the turret in the machine
- Demonstrate how to hold the tool in the turret.

Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
At the end of this unit, you will be able to:

1. Identify various turning tools with respect to operation;
2. Identify the mounting positions and the numbering system.

UNIT 5.8: Tool Number and Offset Number

Unit Objectives

- Machine turret goes back to its resting position after each operation. This can be done by tool offset setting.
- Tool Offset Settings are the settings done on the CNC machine for each tool mounted on the tool turret. This is also called the reference point or the zero setting for each tool with respect to the work piece.
- To achieve the depth fed as per the program we must set each tool touch position with respect to the work piece. This can be achieved by setting individual tool offset position for each tool in the program of the controller.
- Each tool tip will touch the work piece at the point where it has to perform the operation. Feed this reading in the controller. This point acts as the reference point or zero setting for the controller. The controller understands this as start point for that particular operation.
- Every time you change the work piece position or the tool position, the tool offset will have to be redone.
- To know which tool is inserted in which slot, tool numbers are assigned.
Tool Number and Offset Numbers

The Tool number is the slot number in which a particular tool is inserted in the turret. Remember to mention it in the program so that the controller knows as to which tool is available in which slot. The program is automatically amended so that the operation to be performed is performed by the right tool.

For example, the OD turning carbide bit is in turret slot number 1. The program will move the OD carbide bit fixed in slot number 1 every time the OD turning operation is recalled.

Once the tool is fixed in a particular slot number, it can even be recalled to perform two or more operations depending upon the type of operation. For example, facing, OD turning and taper turning all can be done by using the same tool. So every time either of these operations needs to be performed, this particular tool will be put to use.

Do

- Show the tool slots in the machine
- Demonstrate how to do the setting of tool number and offset number in CNC lathe machine.

Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
UNIT 5.9: Work Holding

Unit Objectives

At the end of this unit, you will be able to:

1. Select the appropriate method for clamping the workpiece.

Resources to be Used

- Available objects such as white board, white board marker pens, duster, Participant manual.
- PC with LCD Projector or Flip Chart
- CNC lathe machine, work holding devices i.e. chuck and collet.

Do

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

- Turning operation sequence has to be planned based on the component drawing. It all depends after seeing the component drawing i.e. if the operation will be performed in one setting or multiple settings.
- Component drawing is the basis for deciding what type of job holding device will be used on the machine.
- There are four types of job holding devices or methods. They are:
  - 3 jaw self centering chuck.
  - 4 jaw independent jaw movement chuck.
  - Face plate with center for turning between center to center.
  - Collets.
- Based on the type of job holding required for particular operation the job holding devices or method is fitted on the head stock of the machine.
Important criterion of work holding is that while in operation when the machine is making the job rotate and the cutting operation is taking place, the holding should be strong enough to withstand the load from the cutting tool to the job/work piece.

The operator has to understand and plan the amount of material to be held in the chuck or collet or whatever the holding device is used.

**Do**

- Show the work holding devices to trainees.
- Demonstrate how to connect the work holding devices on headstock safely.

**Notes for Facilitation**

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
UNIT 5.10: Workpiece Setting

Unit Objectives

At the end of this unit, you will be able to:

1. Align the piece with respect to the machine axis.

Resources to be Used

- Available objects such as white board, white board marker pens, duster, Participant manual.
- PC with LCD Projector or Flip Chart
- CNC lathe machine

Do

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

- All the turning operations sequences have to be planned on the basis of the component drawing. It is the component drawing that helps to decide if the operation will be performed in one setting or multiple settings.

- Workpiece setting plays a very important role:
  1. Dimensional accuracy of the final component.
  2. Finish of the final component.
  3. Optimization of machining operation.
  4. Wear and tear of tool and machine.
**Demstrate**

Process of Work Piece Setting

1. **Holding of the job on the chuck, collet or between centres.** The amount of material held inside the chuck collet should be enough to bear the tool cutting load coupled with amount of stock removal per cut at the selected RPM.

2. **Clearances from other parts of the machine.** The workpiece setting has to be planned in such a way that once the job has started, the work pressure on the same after the process of machining should not either make the work piece touch or collide with any other part of machine or become weak enough to fall out of the job holding.

3. Allowance for measurement of the dimensions while the workpiece is loaded on the machine.

4. The workpiece has to be set in such a manner that while the job is held on the machine, measurement of the important dimensions can be conveniently taken without removal of the part from the machine as far as possible.

**Activity**

- Conduct a skill practice activity.
- Ask the students to assemble together.
- Explain the purpose and duration of the activity.
- Set guidelines pertaining to discipline and expected tasks.

<table>
<thead>
<tr>
<th>Skill Practice</th>
<th>Time</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workpiece setting on lathe machine</td>
<td>2 hours</td>
<td>CNC lathe machine and tools required</td>
</tr>
</tbody>
</table>

**Do**

- Divide the class into pairs.
- Go around and make sure they are doing it properly.
Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
At the end of this unit, you will be able to:

1. Identify the error code;
2. Perform the operation to rectify the error.

Resources to be Used

- Available objects such as white board, white board marker pens, duster, Participant manual.
- PC with LCD Projector or Flip Chart
- CNC lathe machine

Do

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

- Today Mohan is going to explain how to troubleshoot lathe machines in case of any faults.
- If there is any issue with the operation of CNC machine with respect to the program, the program refuses to let the operation be performed and sounds an alarm to inform that something is not OK.
- If there is a situation when a lathe stops suddenly or does not start when the start button is pressed; there is some kind of conflict. Read the information displayed to fix the problem and clear the alarm before proceeding.
- Always reset the home position before restarting. If you do not reset the home position then you will have problems with the accuracy of the machine.
Drive failure

The failure phenomenon in drive failure is that the machine starts automatically run, CRT display 401 alarm. In this the machine goes beyond the control of the controller or operator and will not take any command.

If FANUCOM appear alarm no 401 is the meaning of “axis servo drive VRDY signal is disconnected, the drive is not ready”.

Failure analysis and inspection:

1. According to the actual configuration of the meaning of the fault and the machine tool servo feed system maintenance in the following order were checked and confirmed.
2. Check L / M / N axis servo drive, drive status indicator PRDY, VRDY are off.
3. Check the servo drive power AC100V, AC18V were normal.
4. Measure the driver control panel auxiliary control voltage is ± 24V, ± 15V exception.
5. Based on the above examination, initially identify a fault with the drive control power.
6. Carefully check the input power, found on the X-axis servo drive. Input power fuse resistance is greater than 2MΩ, far beyond the specified value.
7. After replacing the fuse again to measure DC auxiliary voltage ± 24V, ± 15V back to normal, the status indicator PRDY, VRDY recovery normal, re-run the machine, 401 alarm disappears.

Vibration Fault

The fault phenomenon of vibration fault is during the Z axis movement, vigorous vibrations appeared, the CNC system does not give any alarm, but the machine does not work. After careful observation and inspection, it is found that movement in a small area (less than 2.5mm), in the Z-axis, the machine is working smoothly without vibration, but more than the above range, machine gives violent vibration.

The machine is a semi-closed loop structure, maintenance was tried by replacing the motor, and it was determined that the cause of the failure was due to the defective pulse encoder.

To understand the root cause of this malfunction, following analysis and testing was carried on:

1. The servo drive main circuit was powered manually and the motor shaft was run, checked the system and found that regardless of the motor forward, reverse, system monitor is able to correctly display the actual position value, indicating that the position encoder signal output were being correctly interfaced.
2. Since the machine Z-axis ball screw pitch is of 5mm, as long as the Z-axis moves around 2mm i.e. vibration occurs, therefore, the cause of the fault may be associated with the actual position of the motor rotor, i.e. pulse encoder rotor position detection signal is not functioning.
3. According to the above analysis, taking into account the Z-axis can be normal movement of about 2.5mm, is equivalent to the actual motor rotation of 180 °, therefore, to further determine the fault location on the rotor position detection signal was reversed.
4. In accordance with the above example, following the same method, remove the pulse encoder; replace the same with a new one and the problem will be solved.

Further examination of the encoder revealed the encoder internal output driver IC has been damaged. After replacing the integrated circuit, re-install the encoder, and press on the cases of the same method of adjusting the angle of the rotor, the machine started working normally.
Do

- Demonstrate the procedure of testing and inspection of lathe machine for drive failure in workshop.
- Demonstrate the procedure of testing and inspection of lathe machine for vibration fault in workshop.

Activity

- Conduct a skill practice activity.
- Ask the students to assemble together.
- Explain the purpose and duration of the activity.
- Set guidelines pertaining to discipline and expected tasks.

<table>
<thead>
<tr>
<th>Skill Practice</th>
<th>Time</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive failure and vibration fault inspection and testing</td>
<td>2 hours</td>
<td>CNC lathe machine and tools required</td>
</tr>
</tbody>
</table>

Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
**At the end of this unit, you will be able to:**

1. State the do’s and don’ts of daily and weekly maintenance.

**Resources to be Used**

- Available objects such as white board, white board marker pens, duster, Participant manual.
- PC with LCD Projector or Flip Chart
- Lathe machine

**Do**

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

**Say**

- Today Mohan is taking a session to emphasis on the importance of routine preventive maintenance of lathe machines.
- Preventive maintenance is the planned maintenance of a plant’s infrastructure and equipment with the goal of improving equipment life by preventing excess depreciation and impairment.
- Preventive maintenance includes adjustments, cleaning, lubrication, repairs, replacements, and the extension of equipment life.

**Elaborate**

**Routine Preventive Maintenance for Lathe**

The CNC machines are based on the linear and rotary movements supported by very precise bearings. The operation of lathe generates lots of burrs, material waste, magnetically charged particles apart from dust and unwanted materials from atmosphere, coolant and materials being used in the operations.
During operation all these unwanted materials can seep in the slides, and bearings. Therefore regular cleaning and external oiling becomes mandatory as part of daily practice of preventive maintenance. Before calling off for the day, machine must be wiped off all the chips, burrs, water, coolant, oil and any other material not required. A thin layer of lubricating oil should be spread on the exposed slides, the joints of the spindles and bearing slides. Before starting the machine afresh; oil must be pumped in through the auto oil feed system to the extent that the minimal quantity of oil is seen bleeding from the slides and spindle ends. If you hear any kind of noise from the machine then the maintenance engineer should be called immediately. Any electrical switch / membrane switch if not functioning or shows delayed functioning should be immediately reported to the maintenance engineer for immediate action.

**Do**

- Demonstrate the procedure of routine maintenance of lathe machine in workshop.

**Ask**

- You could ask about routine maintenance of lathe machine.
- You could ask about how to do routine maintenance of lathe machine.

**Notes for Facilitation**

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the questions at the end of the unit.
- Ensure that every participant answer all the questions.
6. Total Productive Maintenance (TPM)

Unit 6.1 – Introduction (TPM)
At the end of this module, students will be able to:

1. Understand how to increase the productivity of plant and equipment with a modest investment in maintenance.
UNIT 6.1: Total Productive Maintenance

Unit Objectives

At the end of this unit, you will be able to:
1. Understand how to increase the productivity of plant and equipment with a modest investment in maintenance.

Resources to be Used

- Available objects such as white board, white board marker pens, duster, Participant manual.
- PC with LCD Projector or Flip Chart

Do

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

- Total Productive Maintenance (TPM) is a method of conserving and growing the reliability of production and quality systems through the machines, equipment, processes, and employees that add business value to an organisation.
- To prevent delays in manufacturing processes and avoid breakdowns, TPM looks to keep all equipment in excellent working condition.
- A key goal of TPM is to raise the productivity of plant and equipment with a reasonable investment in maintenance.
- The eight pillars of TPM are mostly focused on proactive and preventative techniques for improving equipment reliability:
  1. Autonomous maintenance,
  2. Planned Maintenance,
  3. Quality Maintenance,
  4. Focused Improvement,
  5. Early Equipment Management,
  6. Training and Education,
  7. Safety Health Environment,
  8. TPM in Administration.
Implementation of TPM - Following are the steps involved by the implementation of TPM in an organization:

1. Preliminary assessment of TPM level,
2. Introductory Education and Propaganda (IEP) for TPM,
3. Formation of TPM committee,
4. Development of master plan for TPM implementation,
5. Training of employees and stakeholders on eight pillars of TPM in phase-by-phase manner,
6. Implementation preparation process,
7. Establishing the TPM policies and goals and development of a roadmap for TPM implementation.

The TPM committee should comprise production managers, maintenance managers, and engineering managers. While providing advice, the committee should also frame TPM policies and strategies. A

Objectives of Total Productive Maintenance

The main objective of TPM is to increase the Overall Equipment Effectiveness (OEE) of plant equipment. TPM addresses the causes for accelerated deterioration while creating the correct environment between operators and equipment to create ownership.

Performance x Availability x Quality = OEE

Each factor has two associated losses making 6 in total, these 6 losses are as follows:

- **Performance** = running at reduced speed – Minor Stops
- **Availability** = Breakdowns – Product changeover
- **Quality** = Startup rejects – Running rejects

The objective finally is to identify then prioritize and eliminate the causes of the losses.

Difference between TQM & TPM

TQM is based on five cornerstones:

1. The product,
2. The process that allows the product to be produced,
3. The organization that provides the proper environment needed for the process to work,
4. The leadership that guides the organization, and
5. Commitment to excellence throughout the organization.
TQM focuses on the quality of the product,

Whereas,

TPM focuses on the equipment used to produce the products.

1. By preventing equipment break-down,
2. Improving the quality of the equipment and by standardizing the equipment (results in less variance, so better quality),
3. The quality of the products increases.

Ask

- Ask about TPM.
- Ask about objectives and need of TPM.
- Ask about process of implementing TPM in an organization.
- Ask about difference between TPM and TQM.

Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
7. Inspect and Maintain Product Quality

Unit 7.1 – Introduction to Quality Control
Unit 7.2 – Inspections
Unit 7.3 – Inspections of the final product
Unit 7.4 – CAPA and its implementation
Unit 7.5 – PPAP - PSW
Unit 7.6 – IATF 16949
Unit 7.7 – 8ds
Unit 7.8 – FMEA
Unit 7.9 – The 5 Whys
At the end of this module, students will be able to:

1. Understand Quality Control & Pre-delivery (PDI)
2. Understand the importance of Pre-delivery (PDI)
3. Explain objectives & purpose of inspection.
4. Carry out inspection of final product.
5. Understand different types of Inspection methods (Dimensional / Layout Inspection) & Inspection Tools (Micrometer, Vernier Calipers & Height Gauge).
6. Understand CAPA.
8. Understand the objectives of PPAP-PSW
9. Understand the importance of IATF 16949
10. Understand the discipline 8ds.
11. Explain what is FMEA.
12. Understand the relation between 8D & FMEA.
13. Explain what is 5 Whys.
UNIT 7.1: Introduction to Quality Control

Unit Objectives

At the end of this unit, Students will be able to:

1. Understand Quality Control & Pre-delivery (PDI)
2. Understand the importance of Pre-delivery (PDI)

Resources to be Used

- Available objects such as white board, white board marker pens, duster.
- PC with LCD Projector or Flip Chart
- Participant Manual

Do

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts

Say

- The term “inspection” generally refers to the activity of checking products, whereas “audit” applies to analyzing a manufacturing organization.
- The ISO 2859 standard defines an inspection as an “activity such as measuring, examining, testing or gauging one or more characteristics of a product or service, and comparing the results with specified requirements”.
- The inspected products can be the components used for production, work-in-process inventory, or finished goods.
- Quality control in the automobile industry forms an important aspect of the production process, because of the complexity of the mechanical parts involved and the necessity of their lending themselves to proper assembly with other portions of the engine.
- Combinations of tools and techniques work together in the quality control process within the automobile industry.
- A pre-delivery inspection is a standard procedure carried out by a vehicle sales and workshop team. A pre-delivery inspection ensures that any work that has to be done on the vehicle is carried out prior to the vehicle reaching the customer. The motor vehicle should then be functioning perfectly when the vehicle is sold to the customer.
The pre-delivery inspection will give you one last chance to make sure the items have been manufactured as specified, and will provide the opportunity to do a final quality control check before the goods are shipped.

Elaborate

Pre-delivery inspection (PDI)

In a pre-delivery inspection, taking example of finished vehicle- The vehicle is checked over to ensure that everything is working properly and safely. Often a checklist is worked through. The items on the checklist include such things as the exterior of the vehicle which is inspected for its condition and the installation of panels and attachments. Any defects identified have to be noted.

The interior of the vehicle is also inspected in a pre delivery inspection. This includes the interior condition and installation of any of the panels and items. Defects are identified and noted on the check list. Simple repairs are done on the spot.

In the next part of a pre delivery inspection, the engine is checked over for tightness and leakages. Any simple adjustments can be made, and any simple defects can be rectified. Fluid levels under the bonnet are checked with the engine off.

The engine is also started and brought up to normal operating temperature, and again checks are carried out on fluid levels, leaks and tightness of the engine components. Simple adjustments can be made according to vehicle manufacturer’s specifications. During a pre -delivery inspection, the vehicle will be taken for a run and operated in compliance with the Road Code to test its operation.

Pre-delivery inspections are important for the below reasons

a) It is likely that your goods will be travelling a long distance, and shipping can be both slow and expensive. By making sure that items are right before they are put in their shipping containers could save the time, hassle and expense of returning products that turn out to be unsuitable. This will also help to prevent any gaps in your supply chain.

b) To make sure the goods have been packed properly for transport. This is particularly true for fragile items or products that could go off if inadequately packaged. Pre-delivery inspector can do a number of checks and tests to ensure the shipping conditions are suitable for the goods in question, reducing the chance of breakage or spoilage during shipment.

c) To check that all paperwork and documentations are complete and correct
Ask

- Ask about importance of inspection and quality control.
- Ask about pre-delivery inspection (PDI).
- Ask about things have to check in PDI.

Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
UNIT 7.2: Inspections

Unit Objectives

At the end of this unit, Students will be able to:

1. Explain objectives & purpose of inspection.
2. Carry out inspection of final product.

Resources to be Used

- Available objects such as white Board, white board marker pens, duster, participant manual.
- PC with LCD Projector or Flip Chart

Do

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

- Inspection is the most common method of attaining standardisation, uniformity and quality of workmanship. It is the cost of controlling the product quality after comparison with the established standards and specifications. It is the function of quality control.
- Inspection is an indispensable tool of modern manufacturing process. It helps to control quality, reduces manufacturing costs, eliminate scrap losses and assignable causes of defective work.
- **Purpose of Inspection**
  - To distinguish good lots from bad lots
  - To distinguish good pieces from bad pieces.
  - To determine if the process is changing.
  - To determine if the process is approaching the specification limits.
  - To rate quality of product.
  - To rate accuracy of inspectors.
  - To measure the precision of the measuring instrument.
Objectives of Inspection

1. To collect information regarding the performance of the product with established standards for the use of engineering production, purchasing and quality control etc.
2. To sort out poor quality of manufactured product and thus to maintain standards.
3. To establish and increase the reputation by protecting customers from receiving poor quality products.
4. Detect source of weakness and failure in the finished products and thus check the work of designer.

Stages of Inspection

1. Inspection of incoming material
2. Inspection of production process
3. Inspection of finished goods.

Inspection Procedures

1. Floor Inspection: It suggests the checking of materials in process at the machine or in the production time by patrolling inspectors. This method of inspection minimise the material handling, does not disrupt the line layout of machinery and quickly locate the defect and readily offers field and correction.

Advantages of floor inspection

(1) Encourage co-operation of inspector and foreman.
(2) Random checking may be more successful than batch checking.
(3) Does not delay in production.
(4) Saves time and expense of having to more batches of work for inspection.
(5) Inspectors may see and be able to report on reason of faculty work.

Disadvantages of floor inspection

(1) Difficult in inspection due to vibration.
(2) Possibility of biased inspection because of worker.
(3) Pressure on inspector.
(4) High cost of inspection because of numerous sets of inspections and skilled inspectors.

Suitability of floor inspection

(1) Heavy products are produced.
(2) Different work centres are integrated in continuous line layout.

2. Centralised Inspection: Materials in process may be inspected and checked at centralised inspection centre which are located at one or more places in the manufacturing industry.

Advantages

(1) Better quality check-up.
(2) Closed supervision.
(3) Absence of workers pressure.
(4) Orderly production flow and low inspection cost.

Disadvantages

(1) More material handling.
(2) Delays of inspection room cause wastage of time.
(3) Work of production control increases.
(4) Due to non-detection of machining errors in time, there may be more spoilage of work.

Suitability

(1) Incoming materials inspection.
(2) Finished product inspection.
(3) Departmental inspection.
(4) High precision products of delicate products.
(5) Small and less expensive products.

3. Combined Inspection: Combination of two methods whatever may be the method of inspection, whether floor or central. The main objective is to locate and prevent defect which may not repeat itself in subsequent operation.

Methods of Inspection

1. 100% Inspection: This type will involve careful inspection in detail of quality at each strategic point or stage of manufacture where the test involved is non-destructive and every piece is separately inspected. It requires more number of inspectors and hence it is a costly method.
There is no sampling error. This is subjected to inspection error arising out of fatigue, negligence, difficulty of supervision etc. Hence complete accuracy of influence is seldom attained. It is suitable only when a small number of pieces are there or a very high degree of quality is required. Example: Jet engines, Aircraft, Medical and Scientific equipment.

2. Sampling Inspection: In this method randomly selected samples are inspected. Samples taken from different batches of products are representatives. If the sample proved defective, the entire concerned is to be rejected or recovered. Sampling inspection is cheaper and quicker. It requires less number of Inspectors. It is subjected to sampling errors but the magnitude of sampling error can be estimated. In the case of destructive test, random or sampling inspection is desirable. It is suitable for inspection of products which have less precision importance and are less costly. Example: Electrical bulbs, radio bulbs, washing machine etc.

**Drawbacks of Inspection**

1. Inspection adds to the cost of the product but not for its value.
2. It is partially subjective, often the inspector has to judge whether a product passes or not.
3. Fatigue and Monotony may affect any inspection judgement.
4. Inspection merely separates good and bad items. It is no way to prevent the production of bad items.

**Ask**

- Ask about inspection process.
- Ask about stages and methods of inspection.
- Ask about inspection procedure.

**Notes for Facilitation**

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
UNIT 7.3: Inspections of the final product

Unit Objectives

At the end of this unit, Students will be able to:

1. Understand different types of Inspection methods (Dimensional / Layout Inspection) & Inspection Tools (Micrometer, Vernier Calipers & Height Gauge).

Resources to be Used

- Available objects such as whiteboard, white board marker pens, duster, participant manual.
- PC with LCD Projector or Flip Chart
- Inspection Tools: Micrometer, Vernier Caliper & Height Gauge.

Do

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

- **Dimensional Inspection** is performed to compare the actual condition of a manufactured part or component to the nominal condition as defined by engineering drawings and blueprints, digital files and 3D CAD models, or even a master tool or part.
- **Layout Inspection** is the complete measurement of all part dimensions shown on the design record. A layout inspection may be required by some customers for all products annually unless another frequency is established in a customer approved control plan.
- Inspection tools like micrometer, vernier caliper, height Gauge and other precision instruments are utilized for these inspections.
- The **Vernier Caliper** is a precision instrument that can be used to measure internal and external distances extremely accurately. Measurements are interpreted from the scale by the user. This is more difficult than using a digital vernier caliper which has an LCD digital display on which the reading appears. The manual version has both an imperial and metric scale.
- The **micrometer** is a precision measuring instrument used by engineers. The object to be measured is placed between the anvil face and the spindle face. The ratchet is turned clockwise until the object is ‘trapped’ between these two surfaces and the ratchet makes a ‘clicking’ noise. This means that the ratchet cannot be tightened anymore and the measurement can be read.
A height gauge is a measuring device used either for determining the height of objects, or for marking of items to be worked on. These measuring tools are used in metalworking or metrology to either set or measure vertical distances; the pointer is sharpened to allow it to act as a scriber and assist in marking out work pieces. Height gauges may also be used to measure the height of an object by using the underside of the scriber as the datum.

Demonstrate

Reading the measurement on a Vernier Calipers

Mathematical method:

Step 1: The main metric scale is read first and this shows that there are 13 whole divisions before the 0 on the hundredths scale. Therefore, the first number is 13.

Step 2: The ’hundredths of mm’ scale is then read. The best way to do this is to count the number of divisions until you get to the division that lines up with the main metric scale. This is 21 divisions on the hundredths scale.

Step 3: This 21 is multiplied by 0.02 giving 0.42 as the answer (each division on the hundredths scale is equivalent to 0.02mm).

Step 4: The 13 and the 0.42 are added together to give the final measurement of 13.42mm (the diameter of the piece of round section steel)

Common Method:

- Alternatively, it is just as easy to read the 13 on the main scale and 42 on the hundredths scale. The correct measurement being 13.42mm.

Reading measurements on the micrometer

Step 1: Read the scale on the sleeve. The example clearly shows 12 mm divisions.

Step 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.

Step 3: Finally, the thimble scale shows 16 full divisions (these are hundredths of a mm).

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

- Conduct a skill practice activity.
- Ask the students to assemble together.
- Explain the purpose and duration of the activity.
- Set guidelines pertaining to discipline and expected tasks.
- Do the measurement of given object by using micrometer

<table>
<thead>
<tr>
<th>Skill Practice</th>
<th>Time</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using micrometer and Vernier caliper</td>
<td>2 hours</td>
<td>Micrometer and Vernier caliper</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Micrometer and Vernier caliper Any object for measurement</td>
</tr>
</tbody>
</table>
Do

- Ask them to get practice the activity alone.
- Go around and make sure they are doing it properly.

Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
UNIT 7.4: CAPA and its implementation

Unit Objectives

At the end of this unit, students will be able to:

1. Understand CAPA.
2. Coordinate with R&D / Quality Manager CAPA C1.

Resources to be Used

- Available objects such as white Board, white board marker pens, duster, participant manual.
- PC with LCD Projector or Flip Chart

Do

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

- Corrective and preventive actions (CAPA) are improvements to an organization’s processes taken to eliminate causes of non-conformities or other undesirable situations.
- CAPA is a concept within good manufacturing practice (GMP), and numerous ISO business standards. It focuses on the systematic investigation of the root causes of identified problems or identified risks in an attempt to prevent their recurrence (for corrective action) or to prevent occurrence (for preventive action).
- Corrective actions are implemented in response to customer complaints, unacceptable levels of product non-conformance, issues identified during an internal audit, or adverse or unstable trends in product and process monitoring such as would be identified by statistical process control (SPC).
- Preventive actions are implemented in response to the identification of potential sources of nonconformity.
- CAPA is part of the overall quality management system (QMS).
**Elaborate**

**CAPA Inputs**

Inputs such as Complaints, Quality Records, Servicing, Nonconforming Product Supply Chain, Process Monitoring, Audits and Concessions (Deviations) give specific information to design and deploy CAPA actions.

- **Risk assessment and prioritization** - Risks associated with the above identified inputs are analysed and prioritized as per the SOP/requirement of the organization.
- **Investigation disciplines** - A detailed investigation of the risks are then conducted through various inspection methods.
- **Verification / validation** – The results of the above investigations are validated against desired outcomes and verified for conformity of standards.
- **Well defined action plan** – A CAPA action plan is prepared where all the action items and modifications are defined to the last element.
- **Disseminate information** – Information is then disseminated to the various departments which come under the scope of the CAPA.
- **Documentation rules** – All the standard rules of documenting the CAPA process is carried out as an ongoing activity and checked for conformity.
- **Effectiveness checks** - The CAPA which is set in motion will be checked for its completeness, effectiveness and confirmation to the set timelines.
- **Management escalation** – The problems identified, if any, after determining their severity, are escalated to the management for review

**Ask**

- Ask about CAPA.
- Ask about CAPA Inputs.

**Notes for Facilitation**

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
UNIT 7.5: PPAP - PSW

Unit Objectives

At the end of this unit, students will be able to:

1. Understand the objectives of PPAP-PSW.

Resources to be Used

- Available objects such as whiteboard, white board marker pens, duster, participant manual.
- PC with LCD Projector or Flip Chart

Do

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

- The Part Submission Warrant or PSW is a document that summaries the whole ‘PPAP Package’.

Elaborate

PSW document include following details:

1) Part Information

- **Part Name** - The part name is the parts official name for example Pedal Box or Bonnet Locking Platform. This benefits the manufacturer by giving the part a more human name and decreasing the chance of errors for example calling the part QNCA0001450002N could easily be mixed up if multiple PPAPs were being discussed.

- **Part Name on Drawing** - The part name on the drawing is the part ID written or stamped onto the drawing for example QNCA0001450002N.

- **Engineering Change Level** - Will be specified by the manufacturer and could include any manufacturing change such as tool modifications.
• **Engineering Change Date** - The date of these changes.

• **Additional Engineering Changes** - Will be specified by the manufacturer and could include any manufacturing change such as tool modifications.

• **Additional Engineering Changes Date** - The date of these changes.

• **Safety and/or Government Regulation** - Are there any safety and/or government regulation that the manufacturer need to be aware of. These should be listed and relevant documents included or referred to.

• **Checking Aid Number** - ID of any special tools used while completing the PPAP.

• **Checking Aid Engineering Change Level** - What is the level of the checking equipment you use to check this part are there any special tools used?

• **Checking Aid Engineering Change Date** - Date of the Checking Aid.

• **Customer Part Number** - The number the customer uses on their system to identify the part. This is very helpful to know when speaking to different department in the manufacturers company as not everyone will know the suppliers part number.

• **Organization Part Number** - The number the organization uses on their system to identify the part.

• **Purchase Order Number** - The ID of the manufacturers purchase order.

• **Weight** - Weight of the material ordered.

2) **Suppliers Contact Information**

• Name of Supplier and/or Vendor Code

• Suppliers Address

3) **The Customers Contact Information**

• Customers Name and Division

• Any buyer code

4) **Materials Reporting**

• May need to be submitted, Could be COSH data sheets IMDS format.

• In what format will you submit IMDS or IMDS like information? IMDS ID.

• What is the module or IMDS number?

5) **Reason for Submission**

There can be many reasons why it is necessary to conduct a PPAP:

I. Initial Submission

II. Engineering Changes
III. Tooling: Transfer, Replacement, Refurbishment, or Additional
IV. Correction of Discrepancy
V. Tool Inactive > 1 Year
VI. Change to Optional Construction or Material
VII. Supplier or Material Source Change
VIII. Change in Part Processing
IX. Parts Produced at Additional Location
X. Other (Specify)

6) Requested Submission Level

There are different levels of PPAP submission

1. **Level 1** – Warrant only submitted to customer
2. **Level 2** – Warrant with product samples and limited supporting data
3. **Level 3** – Warrant with product samples and complete supporting data
4. **Level 4** – Warrant and other requirements as defined by customer
5. **Level 5** – Warrant with product samples and complete and complete supporting data reviewed at suppliers manufacturing location.

7) Submission Results

i. Dimensional measurements
ii. Material and function tests
iii. Appearance Criteria
iv. Statistical process package

Do all the results meet all the design requirements with any concerns noted Mold / Cavity /Production Process ID

8) Declaration

9) Explanations or Comments

- Comments / Explanations
- Customer tool tags
- Signature and Date
- Printed name
- Phone Number/Fax Number
10) Status
Sign off by customer

Ask
- Ask about PSW.
- Ask about details required in a PSW.

Notes for Facilitation
- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
UNIT 7.6: IATF 16949

Unit Objectives

At the end of this unit, Students will be able to:

1. Understand the importance of IATF 16949

Resources to be Used

- Available objects such as whiteboard, white board marker pens, duster, participant manual.
- PC with LCD Projector or Flip Chart

Do

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

- IATF 16949 was prepared by the International Automotive Task Force (IATF), with support from ISO/TC 176, Quality management and quality assurance.
- IATF 16949 specifies the requirements of ISO 9001 for automotive production.
- This technical specification combines all previous and published national automotive quality standards such as QS-9000, VDA 6.1, EAQF 94, and AVSQ.

Elaborate

Why is IATF 16949 important?

IATF 16949 certification demonstrates that your company has met the quality management system requirements to create a process of continuous improvement with an emphasis on defect prevention and reduction of variation and waste in the supply chain. The technical specification is implemented for all branches of manufacturers and suppliers of products or production materials, services such as heat treatment or galvanizing, and other products specified by automotive customers such as the constituent parts of vehicles.
Certification to this technical specification is recognized by leading automotive manufacturers and OEMs. Most leading manufacturers will only work with companies that hold IATF 16949 certification.

**What are the key benefits?**

- A commercial advantage during contract negotiations.
- A clear focus on continual improvement, emphasizing defect prevention and reduction of variation and waste.
- Time and cost savings, by avoiding multiple customer specific certification audits.

**Ask**

- Ask about IATF 16949 certification.
- Ask about benefits of IATF 16949 certification.

**Notes for Facilitation**

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
UNIT 7.7: 8Ds

Unit Objectives

At the end of this unit, Students will be able to:

1. Understand the discipline 8Ds.

Resources to be Used

- Available objects such as whiteboard, white board marker pens, duster, participant manual.
- PC with LCD Projector or Flip Chart

Do

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

- Eight Disciplines (8Ds) is a problem solving method developed at Ford Motor Company used to approach and resolve problems, typically employed by engineers or other professionals.
- Focused on product and process improvement, its purpose is to identify, correct, and eliminate recurring problems.
- It establishes a permanent corrective action based on statistical analysis of the problem and on the origin of the problem by determining the root causes.
- 8D follows the logic of the PDCA cycle.
- 8Ds has become a standard in the automotive, assembly and other industries that require a thorough structured problem solving process using a team approach.

Elaborate

8D are:

- **D0**: Plan: Plan for solving the problem and determine the prerequisites.
• **D1:** Use a Team: Establish a team of people with product/process knowledge.

• **D2:** Describe the Problem: Specify the problem by identifying in quantifiable terms the - who, what, where, when, why, how, and how many (5W2H) for the problem.

• **D3:** Develop Interim Containment Plan: Define and implement containment actions to isolate the problem from any customer.

• **D4:** Determine, and Verify Root Causes and Escape Points: Identify all applicable causes that could explain why the problem has occurred. Also identify why the problem was not noticed at the time it occurred. All causes shall be verified or proved. One can use five whys or Ishikawa diagrams to map causes against the effect or problem identified.

• **D5:** Verify Permanent Corrections (PCs) for Problem will resolve problem for the customer: Using pre-production programs, quantitatively confirm that the selected correction will resolve the problem. (Verify that the correction will actually solve the problem.)

• **D6:** Define and Implement Corrective Actions: Define and Implement the best corrective actions.

• **D7:** Prevent Recurrence: Modify the management systems, operation systems, practices, and procedures to prevent recurrence of this and all similar problems.

• **D8:** Congratulate Your Team: Recognize the collective efforts of the team. The team needs to be formally thanked by the organization.

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**Ask**

- Ask about what is 8D?
- Ask about 8D’s.

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**Notes for Facilitation**

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
UNIT 7.8: FMEA

Unit Objectives

At the end of this unit, Students will be able to:

1. Explain what is FMEA.
2. Understand the relation between 8D & FMEA.

Resources to be Used

- Available objects such as whiteboard, white board marker pens, duster, participant manual.
- PC with LCD Projector or Flip Chart

Do

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

- FMEA is called failure modes and effects analysis.
- Failure modes and effects analysis (FMEA) is a step-by-step approach for identifying all possible failures in a design, a manufacturing or assembly process, or a product or service.
- “Failure modes” means the ways, or modes, in which something might fail. Failures are any errors or defects, especially ones that affect the customer, and can be potential or actual. “Effects analysis” refers to studying the consequences of those failures.
- The purpose of the FMEA is to take actions to eliminate or reduce failures, starting with the highest-priority ones.
- **When to Use FMEA**
  - When a process, product or service is being designed or redesigned, after quality function deployment.
  - When an existing process, product or service is being applied in a new way.
  - Before developing control plans for a new or modified process.
  - When improvement goals are planned for an existing process, product or service.
FMEA Procedure

- Assemble a cross-functional team of people with diverse knowledge about the process, product or service and customer needs. Functions often included are: design, manufacturing, quality, testing, reliability, maintenance, purchasing (and suppliers), sales, marketing (and customers) and customer service.

- Identify the scope of the FMEA. Is it for concept, system, design, process or service? What are the boundaries? How detailed should we be?

- Fill in the identifying information at the top of FMEA form.

- Identify the functions of scope. Ask, “What is the purpose of this system, design, process or service? What do our customers expect it to do?”

- For each function, identify all the ways failure could happen.

- For each failure mode, identify all the consequences on the system, related systems, process, related processes, product, service, customer or regulations. These are potential effects of failure.

- Determine how serious each effect is. This is the severity rating or S and it is usually rated on a scale from 1 to 10, where 1 is insignificant and 10 is catastrophic. If a failure mode has more than one effect, write on the FMEA table only the highest severity rating for that failure mode.

- For each failure mode, determine all the potential root causes. Use tools classified as cause analysis tool, as well as the best knowledge and experience of the team. List all possible causes for each failure mode on the FMEA form.

- For each cause, determine the occurrence rating, or O. This rating estimates the probability of failure occurring for that reason during the lifetime of your scope. Occurrence is usually rated on a scale from 1 to 10, where 1 is extremely unlikely and 10 is inevitable.

- For each cause, identify current process controls. These are tests, procedures or mechanisms that you now have in place to keep failures from reaching the customer.

- For each control, determine the detection rating, or D. This rating estimates how well the controls can detect either the cause or its failure mode after they have happened but before
the customer is affected. Detection is usually rated on a scale from 1 to 10, where 1 means the control is absolutely certain to detect the problem and 10 means the control is certain not to detect the problem (or no control exists).

• (Optional for most industries) Is this failure mode associated with a critical characteristic? (Critical characteristics are measurements or indicators that reflect safety or compliance with government regulations and need special controls.) If so, a column labelled “Classification” receives a Y or N to show whether special controls are needed. Usually, critical characteristics have a severity of 9 or 10 and occurrence and detection ratings above 3.

• Calculate the risk priority number, or RPN, which equals S × O × D. Also calculate Criticality by multiplying severity by occurrence, S × O. These numbers provide guidance for ranking potential failures in the order they should be addressed.

• Identify recommended actions. These actions may be design or process changes to lower severity or occurrence.

• As actions are completed, note results and the date on the FMEA form. Also, note new S, O or D ratings and new RPNs.

**Relationship between 8D and FMEA**

• The problem statements and descriptions can be linked between both documents. An 8D can be completed faster by utilizing easy to locate, pre-brainstormed information from a FMEA to solve problems.

• Possible causes in a FMEA can immediately be used to jump start 8D Fishbone or Ishikawa diagrams. Brainstorming information that is already known is not a good use of time or resources.

• Data and brainstorming collected during an 8D can be placed into a FMEA for future planning of new product or process quality. This allows a FMEA to consider actual failures, occurring as failure modes and causes, becoming more effective and complete.

• The design or process controls in a FMEA can be used in verifying the root cause and permanent Corrective Action in an 8D.

• The FMEA and 8D should reconcile each failure and cause by cross documenting failure modes, problem statements and possible causes. Each FMEA can be used as a database of possible causes of failure as an 8D is developed.
• Ask about what is FMEA?
• Ask about FMEA procedure.
• Ask about relationship between FMEA and 8D.

Notes for Facilitation
• Summarize the main points.
• Ask participants if they have any doubts.
• Encourage them to ask questions.
• Answer their queries satisfactorily.
UNIT 7.9: The 5 Whys

Unit Objectives

At the end of this unit, Students will be able to:

1. Explain what is 5 Whys.

Resources to be Used

- Available objects such as whiteboard, white board marker pens, duster, participant manual.
- PC with LCD Projector or Flip Chart

Do

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

- A discussion of the unexpected event or challenge that follows one train of thought to its logical conclusion by asking “Why?” five times to get to the root of what happened.
- The 5 Whys technique was developed and fine-tuned within the Toyota Motor Corporation as a critical component of its problem-solving training.

Elaborate

5 Why process

- **Invite anyone affected by the issue:** As soon as the problem or situation is identified (and all immediate concerns are dealt with), invite anyone at all on the team who was affected or noticed the issue to be involved in a 5 whys meeting.

- **Select a 5 Whys master for the meeting:** The 5 Whys master will lead the discussion, ask the 5 whys and assign responsibility for the solutions the group comes up with. The rest of those involved will answer those questions and discuss.
• **Ask “why” 5 times:** Dig at least 5 levels deep into the issue with 5 levels of “whys.” This seems like the simplest part, but can in fact get a bit difficult in getting the right question to start with, the first why, seems to be the key.

• **Assign responsibility for solutions:** At the end of the exercise, go through each why question and-answer pairing and come up with 5 related “corrective actions” that everyone agree on. The master assigns responsibility for the solutions to various participants in the discussion.

• **Share the results:** After each 5 Whys process, someone involved in the meeting will write down what was discussed in the clearest, plainest language as possible and shares the result with all concerned.

---

**Ask**

- Ask about what is 5Whys?
- Ask about 5Whys procedure.
- Ask about need of 5Why.

---

**Notes for Facilitation**

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
8. Maintaining a safe, Clean and secure working environment

Unit 8.1 – Health Safety and Security procedure
Unit 8.2 – PPE of Workers
Unit 8.3 – Hazards
At the end of this module, students will be able to:

1. Understand health, safety and security procedure
2. Identify the Safety Equipment required
3. Identify activities causing potential hazards.
4. Explain safe practises for avoiding hazards.
UNIT 8.1: Health, Safety and Security procedure

Unit Objectives

At the end of this unit, you will be able to:

1. Understand health, safety and security procedure

Resources to be Used

• Available objects such as whiteboard, white board marker pens, duster.
• PC with LCD Projector or Flip Chart
• Participant Manual

Do

• Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

• Health, safety and security procedures refer to the guidelines and rules that make sure that people in the workplace, whether they are employers, employees or other visitors are safe and secure.
• These procedures tell employees or employers how they should carry out their tasks around the workplace in a way that ensures a minimization in accidents, incidents, contraction of diseases and security breaches.

Elaborate

Preventative procedures may include:

• Educating staff on manual handling, i.e.: how to lift and move objects properly to avoid an injury
• Educating staff on how to minimize back and neck pain by using ergonomic furniture in an appropriate fashion
• Giving detailed instructions on how to use equipment
• Educating staff on the importance of wearing appropriate protective gear to handle certain pieces of equipment
• Instructing staff on how to keep the workplace secure, by teaching them about the security systems in place and how to use them so that cash, equipment and people are safe and secure
• Educating staff on potential hazards in the workplace.
• Health, safety and security procedures also refer to what you should do when accidents or incidents do occur.

Ask

• Ask about organization safe operating procedures
• Ask about need of safe operating procedures

Notes for Facilitation

• Summarize the main points.
• Ask participants if they have any doubts.
• Encourage them to ask questions.
• Answer their queries satisfactorily.
UNIT 8.2: PPE of Workers

Unit Objectives

At the end of this unit, you will be able to:

1. Identify the Safety Equipment required

Resources to be Used

• Available objects such as whiteboard, white board marker pens, duster, participant manual.
• PC with LCD Projector or Flip Chart.
• PPE

Do

• Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

• PPE refers to the equipment worn by staff to reduce the exposure to hazards.
• PPE include such items as: gloves, safety boots, earplugs, safety hat, face mask, welding shield etc.
• There are two things to consider in regards to PPE:
  o PPE protects only the wearer, whereas measures controlling the risk at source can protect everyone in the workplace.
  o The specified level of protection in reality may not be achieved with PPE and the actual level of protection provided is difficult to assess.
Elaborate

PPE items may include:

- **Gloves** – Always wear gloves when you are working with any sharp tools, knives or materials. You should also wear gloves when working with some cleaning agents, glues, etc.

- **Foot protection (safety boots)** - Safety boots are necessary if you are working in a building site or in an area where heavy objects can fall on you.

- **Body protection** – aprons, gowns - Additional protective clothing may be necessary when cleaning duties require the use of various chemicals and/or disinfectants.

- **Hearing protection** – ear muffs, ear plugs - Ear muffs should be used when working in an environment to protect your ears if there is regular noise or occasional sounds that are louder.

- **Face masks** – Use face masks to get the protection from gases, poisonous fumes, dust, vapours etc. Face mask protect our self from flying particles and harmful radiation.

- **Head protection** – hard hats - If you are working in an area where tradesmen are working above you, you should wear a hard hat.

- **Eye protection** – goggles, glasses - When working outside you should wear protection glasses to protect you from the sun ultra -violet rays.

Ask

- Ask about PPE
- Ask about need of PPE

Do

- Show the PPE to trainees.
- Demonstrate them how to wear the PPE properly.
- Explain the functioning of every item of PPE.

Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
**UNIT 8.3: Hazards**

**Unit Objectives**

At the end of this unit, you will be able to:

1. Identify activities causing potential hazards.
2. Explain safe practices for avoiding hazards.

**Resources to be Used**

- Available objects such as whiteboard, white board marker pens, duster, participant manual.
- PC with LCD Projector or Flip Chart.

**Do**

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

**Say**

- A hazard is a situation that poses a level of threat to life, health, property, or environment.
- The main hazards can happen during work are:
  - Fire caused by heat, sparks, molten metal or direct contact with the flame.
  - Explosion when cutting up or repairing tanks or drums which contain or may have contained flammable materials.
  - Fire/explosion caused by gas leaks, backfires and Flashbacks.
  - Fumes created during flame cutting.
  - Fire/burns resulting from misuse of oxygen.
  - Burns from contact with the flame or hot metal.
  - Crushing or impact injuries when handling and transporting cylinders.
- To assure a high degree of safety, no machine-tool is to be used unless the risk management process applied on it.
• While working in workplace you have to follow personal safety procedures when dealing with tools and equipments. You have to follow Standard Operating Procedures (SOP’s) must be maintained for each piece of machinery in the shop.

• **The Hazardous Material can be:** Flammable, Reactive, Toxic and Corrosive.

---

**Elaborate**

**Risk management process**

1. Identify the potential hazard(s) that the machine tool can generate.
2. Assess the probability and severity of the hazard(s) by utilizing the Risk Assessment Matrix. Risk acceptance decision authority for the risk levels is as follows:
   a. Extremely high - Loss of ability to accomplish mission.
   b. High - Significantly degrades mission capabilities in terms of required mission standards.
   c. Moderate - Degrades mission capabilities in terms of required mission’s standards.
   d. Low - Little or no impact on accomplishment of mission.
3. Determine the risk control measures that will eliminate the hazard(s) or reduce the risk.
4. Supervise and evaluate the process. Enforce the established standards and risk control measures.

**Probability of hazard**

- **Frequent** - Occurs often in the career/equipment service life. Continuously experienced during operation.
- **Likely** - Occurs several times in career/equipment service life. Occurs frequently during operation.
- **Occasional** - Occurs sometimes in career/equipment service life. Occurs periodically or several times in inventory service or operations.
- **Remote** - Possible to occur in career/equipment service life. Expected to occur sometime in inventory service life or operation.
- **Unlikely** - Can assume will not occur in career/ equipment/ service life. Possible, but improbable; occurs only very rarely during operation.

**Severity of hazard**

- **Catastrophic** - Death or permanent total disability, system loss or major property damage.
• **Critical** - Permanent partial disability, temporary total disability in excess of 3 months, major system damage or significant property damage.

• **Marginal** - Minor injury, lost workday accident with compensable injury/illness, mirror system damage or minor property damage.

• **Negligible** - First aid or minor treatment or minor system impairment.

**Remedial action procedure:**

1. If you find any problem or hazard situation, remedial action should be completed as soon as possible.

2. Give remedial action priority to hazards with more severe loss potential.

3. Obtain target dates for correction. Use hazard classification to motivate correction.

4. Write a detailed explanation of the hazard and its potential loss severity as justification for any action requiring a major expenditure and forward it to the person most responsible for corrective action.

5. Encourage responsible persons to take permanent corrective action (repetitive remedy is costly).

6. Make sure intermediate (temporary) safety measures are taken whenever permanent or complete remedy will require additional time.

7. At a reasonable time after the inspection is conducted and necessary action is submitted, do a follow-up walk through to ensure that the corrective action has been completed.

8. Make sure all reports are properly filed and maintained for record purposes.

**Hazardous work practices:**

• **Hot Work:** Hot work is defined as any work producing an arc, flame, or spark. The only exception to this are those areas specifically designed and or built for welding, cutting or brazing.

• **Confined Space Entry:** Entry to confined spaces is very dangerous and requires special precautions in addition to a permit issued by a supervisor. Confined spaces are defined as tanks, vessels, sewers, pits, boilers, manholes, etc.

• **Lockout:** Everyone who works on or is endangered by equipment that is powered by an energizing source, such as electricity, steam, hydraulics, or pneumatic power shall shut it off and lock it out prior to performing any maintenance work.

• **High Voltage Electricity:** Only specially trained maintenance employees/electricians are permitted to work with high voltage equipment.
The main hazards in machining works are:

- Fire caused by heat, sparks, molten metal or direct contact with the flame.
- Explosion when cutting up or repairing tanks or drums which contain or may have contained flammable materials
- Fire/explosion caused by gas leaks, backfires and flashbacks
- Fumes created during flame cutting
- Fire/burns resulting from misuse of oxygen
- Burns from contact with the flame or hot metal

Safe practices for avoiding general shop hazards:

1. Never use compressed air to blow chips away from a machine
2. Keep the floor clear of stock and tools, and clean spilled oils or coolants
3. Know where the fire extinguisher is kept and how to use it
4. Always keep machines turned off when making adjustments to them

Safe practices for avoiding machine hazards

1. Am I familiar with the operation of this machine?
2. What are the potential hazards involved with using this machine?
3. Are all safety guards in place?
4. Are my procedures safe?
5. Am I doing something that I probably should not do?
6. Have I made all the proper adjustments and tightened all locking mechanisms?
7. Is the workpiece secured properly?
8. Do I have proper safety equipment?
9. Do I know how to turn off the machine quickly if necessary?
10. Do I think about safety in everything I do?
Ask

- You can ask the different ideas to control the hazard.
- You could ask the common causes of hazard.
- You can pick the students and ask the safe practices for avoiding general shop hazards.

Team Activity

- Conduct a skill practice activity.
- Ask the students to assemble together.
- Explain the purpose and duration of the activity.
- Make the 5 teams.
- Divide the complete training center area into five different areas like cafeteria, workshop, classroom, training center admin block, washrooms etc.
- Assign one area to each team.
- Tell them to go their area and identify the reasons of hazards in that area.
- Once they back, they have to present what type of hazards they identified and what precautions have to be taken to control those hazards.
- Go around and make sure they are doing it properly.
- Wrap the unit up after summarizing the key points and answering questions.

Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
9. Soft Skill

Unit 9.1 – Stress Management
Unit 9.2 – Work Ethics
Unit 9.3 – Attitude
Unit 9.4 – Communication
Unit 9.5 – Problem Solving Skills
At the end of this module, students will be able to:

1. Reduce, prevent, and cope with stress;
2. Demonstrate good work ethics;
3. Demonstrate positive attitude towards superiors, peers and other service providers;
4. Practice good oral and written communication skills;
5. Explain what are problem solving skills;
At the end of this unit, you will be able to:

1. Reduce, prevent and cope with stress.

Resources to be Used

- Available objects such as whiteboard, white board marker pens, duster, participant manual.
- PC with LCD Projector or Flip Chart

Do

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

- Stress is a normal emotion. Stress management may be critical for people who find it difficult to keep it under control.
- Stress is our body’s response to change. Our body responds by releasing hormones such as adrenaline and cortisol. These hormones cause our breathing and heart rate to speed up, and our blood pressure to rise. These reactions help us to react quickly and effectively to get through the situation at hand.
- There are many health issues related to stress like heart attack, high blood pressure, anxiety, depression, colds and flu/fever and digestive problems. If your heart beats faster and you breathe quickly, tension in your shoulder or clinching your fists etc.
- Optimum amount of stress helps to motivate us to get a task finished, or perform well. But, the problems come when stress is chronic and our body remains in high gear, off and on, for days or weeks at a time. Constant stress may then interfere with our ability to get on with our normal life.
- So, sometimes stress is good for us. The key is to manage stress properly. Unhealthy responses to stress may lead to health problems.
- Stress can come from happy events (job promotion, buying a new house) as well as unhappy events (illness, overwork, family problems).
• As a CNC machinist, small mistakes at the job front can be stressful. In addition to this the daily grind of – broken tools, scrapping an otherwise good part, an angry boss and sometimes even unhappy customers can cause stress.

• It is important for you to understand what is causing stress for you.

• Once you know how stress makes you feel, it’s important to have strategies for soothing or calming yourself down. Taking steps to manage stress will help you feel more in control of your life.

Causes and Symptoms of Stress

• It can make you feel angry, afraid, excited or helpless.
• It can make it hard to sleep.
• It can give you aches in your head, neck, jaw and back.
• It can make you feel overwhelmed and out of control.
• It can make it difficult for you to concentrate.
• It can even weaken your immune system.
• It can lead to habits like smoking, drinking, overeating or drug abuse.

Controlling Stress

• Check your self-talk – Saying things like: ‘I can’t cope’, or ‘I’m too busy’, or ‘I’m so tired’, or ‘It’s not fair’ can make you feel worse. Instead try saying soothing, calming things to yourself like ‘I’ll do the best I can’, ‘calm down’ or ‘breathe easy’.

• Make sure you are eating healthy food. Some foods with high fat, sugar, caffeine and salt can contribute to stress.

• Take time to do activities you find calming or uplifting, such as listening to music, walking or dancing.

• Avoid using alcohol, tobacco or other drugs to cope.

• Make time for yourself - take 15 to 20 minutes a day to sit quietly, relax, breathe deeply and think of a peaceful situation.

• Engage in physical activity regularly. Do what you enjoy — walk, swim, ride a bike or do yoga.

• Build a support system. Talking with friends or family about problems you have or decisions that you must make.

• Identify areas of agreement and disagreement and look for options to resolve the conflicts.

• Improve your ability to see options and resources that can be used to solve problems.
• Plan ahead - allow enough time to get the important things done. Remember, stress multiplies when you leave things for the last minute.
• Try to get 6 to 8 hours of sleep each night.
• Last but not the least - Laugh.

Ask

• Ask about stress management.
• Ask about symptoms of stress.
• Ask about methods of controlling stress.

Activity

• Ask the students to assemble in pairs.
• Ask the students about situations when they realized that their stress disabled them from performing their best.

Notes for Facilitation

• Summarize the main points.
• Ask participants if they have any doubts.
• Encourage them to ask questions.
• Answer their queries satisfactorily.
• Tell participants to complete the exercise at the end of the unit.
• Explain the exercise and ensure that every participant is doing the exercise.
Unit Objectives

At the end of this unit, you will be able to:

1. Demonstrate good work ethics.

Resources to be Used

- Available objects such as whiteboard, white board marker pens, duster, participant manual.
- PC with LCD Projector or Flip Chart

Do

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

- Work ethic is a set of moral principles or standard work norms practices by an employee to promote the overall welfare of the company.
- Strong work ethic is the key to good performance.
- It is important to know about indicators of bad work ethics and good work ethics.
- Personal grooming is also a key of good work ethics.
- Did you know 55% of what the other person thinks of you is based on how you present yourself. Poor personal appearance and careless dressing can affect your career negatively.
- If you smile and dress neatly – people think that you are pleasant, whereas, if you wear torn and wrinkled clothes people might conclude you’re careless and irresponsible. You must look and act positively to project the image you want others to receive.
- To appear professional, you must observe good habits of grooming and personal hygiene.
Indicators of bad work ethics

- Procrastination
- Irregular Attendance
- Politicking and Gossiping
- Bad Mouthing the Company
- Lack of Discipline
- Untidy Appearance

Indicators of strong work ethics

- Integrity
- Sense of Responsibility
- Initiative
- Maintain Quality
- Discipline
- Respect
- Appearance

Grooming

Grooming is the processes of making yourself appear neat and tidy. Grooming involves overall cleanliness and personal hygiene.

Grooming check list:

- Comb your hair neatly.
- Wash your hair at least once a week.
- Keep your moustache neatly trimmed.
- Shave regularly.
- Brush your teeth twice a day and rinse after every meal.
- Avoid bad breath.
- Keep your nails short and ensure they are grime free.
- Iron your clothes and keep them neat and clean.
- If you are required to wear uniforms, you must take care of your uniform and report any damage to your supervisors.
- Do not wear the uniform outside the work premises.
- If you wear a turban, ensure that it is neatly tied.
- Avoid clothing that can create a safety hazard.
- Make sure your shoes are in a good condition and polished.
- Use mild deodorant to avoid bad body odor.

**Ask**

- Ask the students to write about why one’s uniform should be neat, clean and ironed.
- Ask the students to discuss the importance of uniform in school.
- Also ask them to discuss about incidents when they formed an opinion about others based on their dress.

**Activity**

- Ask the students to assemble in pairs.
- Ask the students to write about why one’s uniform should be neat, clean and ironed.

**Notes for Facilitation**

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the exercise at the end of the unit.
- Explain the exercise and ensure that every participant is doing the exercise.
UNIT 9.3: Attitude

Unit Objectives

At the end of this unit, you will be able to:

1. Demonstrate positive attitude towards superiors, peers and other service providers.

Resources to be Used

- Available objects such as whiteboard, white board marker pens, duster, participant manual.
- PC with LCD Projector or Flip Chart

Do

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

- The attitude of a person includes various aspects like- our approach, our outlook towards situations and others, the emotions we express towards others.
- If you walk around the workplace with a negative attitude, you are less likely to be approachable. An optimistic attitude on the other hand will enable you to gain the trust and acceptability of your peers and create a better workplace.
- Most people prefer to be around people with a positive attitude. So developing a positive attitude can help you get more both, professionally and personally.
- If you pause and think, you will probably come up with dozens of examples where your negative attitude may have caused problems or conflict in your personal and professional relationships.
- It is important to develop positive attitude in you. A positive attitude has the ability to deal with even the most difficult situations.
- A positive attitude in the workplace is like walking around with your promotion ticket in your pocket.
Benefits to having a positive work attitude

- Bounce back from adversities.
- Cope with stressful situations at work.
- View failure as a learning experience and adopt new approaches.
- Build self confidence and belief in your own abilities.
- Enhance creativity. Since positive attitudes are at the heart of all innovation.
- Resolve conflicts in your personal and professional relationships.
- Better manage and express your emotions.
- Build empathy and readily see how other people think and feel.
- Keep motivated and keen to learn.
- Inspire and motivate others.
- Become a role model for others and garner more respect.
- Promote a “Can-Do” culture at work.
- Be perceived as a leader and get more special projects to work on.

Strategies that will help you cultivate a positive attitude at work

- **Smile**: It’s truly amazing how powerful a smile can be. It naturally makes you feel more positive and improves other people’s outlook towards you.

- **Look for a solution and not the problem**: Negative people see obstacles; whereas positive people turn every challenge into an opportunity. Try and look for solutions instead of simply saying “That won’t work.”

- **Respect the people around you**: Give your peers and subordinates the respect they deserve. If you do not agree with someone talk to that person in private instead of confronting them in public. Talk about the issue at hand and not about the person. Stay away from gossip.

- **Work towards continuous improvement**: Keep yourself updated about the latest development in your work field. Always look for ways to improve your work competencies.

- **Be constructive**: Look at a problem as an opportunity in disguise.

- **Set realistic goals**: Set goals that are achievable. Take your strengths and weaknesses into account, and focus on accomplishing your tasks.

- **Be pleasant and polite**: You should be polite to superiors, peers, and subordinates alike. Too often people are only polite to their superiors or those individuals they consider can help them progress in their careers.
Ask

- Ask about importance of positive attitude.
- Ask about how to impart positive attitude.

Activity

- Make 5-7 slips stating a difficult situation, for instance- there is an annual event in the school. Due to some reason the tent house people could not manage to come there and carry out the tent and other decoration work. The event is just 1hr away. How would you manage the situation?
- After everybody has received a chit, give the students a time of 2-4mins. to think over the situation and write a possible solution.
- Collect the slips of the people who have got same situations. Compare them in terms of practical application, positivity, etc.
- Suggest other possible solutions.
- Applaud the students whose answers show the correct attitude and will to deal with the situation using their creativity.

Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the exercise at the end of the unit.
- Explain the exercise and ensure that every participant is doing the exercise.
UNIT 9.4: Communication

Unit Objectives

At the end of this unit, you will be able to:

1. Practice good oral and written communication skills.

Resources to be Used

- Available objects such as whiteboard, white board marker pens, duster, participant manual.
- PC with LCD Projector or Flip Chart

Do

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

Say

- Communication is a process by which information travels from a source to the receiver. For it to be successful, the receiver must understand the message in the way that the sender intended. Sources and receivers can be individuals or groups.

- The source encodes the communication into a message, and transmits it through a channel. The receiver decodes the message and gives feedback one way or another.

- Communication is of two types: Verbal and Non-verbal.

- Any form of oral and written communication can be clubbed under verbal communication. Most oral communication involves people speaking to each other, either face to face or on the telephone.

- Communication can be non-verbal, which means that it does not use words to transfer information. Non-verbal communication includes: facial expressions, body language and gestures.

- To deliver and receive messages effectively, you must commit to breaking down the barriers to communication.

- Communication barriers are like walls that prevent messages from being properly sent or received. Often, due to the nature of the environment or our psychological perceptions we cannot communicate properly.
Advice to improve non-verbal communication skills

- Maintain eye contact.
- Nod your head to convey that you are listening or that you agree.
- Smile and show interest.
- Lean forward to show the speaker you are interested.
- Use a tone of voice that matches your message.
- Portray appropriate facial expressions.
- Avoid distracting actions or gestures.

Communication barriers

- **Preoccupation**: Sometimes a person may have something else on his mind and may not be able to listen at all.
- **Hostility**: When two people are hostile, each often distorts messages from the other in such a way that hostility further increases.
- **Inarticulateness**: Simple inarticulateness may distort the message.
- **Physical Environment**: The environment alone may create conditions under which communication cannot take place effectively.
- **Status**: The most difficult condition to overcome in communication is that of status. For instance, while passing information to his superior one tends to screen out information detrimental to their welfare and tend to pass along information that helps their cause.
- **Lengthy Messages**: If a message is too lengthy and disorganized the recipient may lose interest in the communication.
- **Poor body language**: Inappropriate body language can often confuse the recipient. For instance, you may be very interested in the conversation, but your yawning and glazed eyes may show that you are bored.
- **Jargon**: Technical jargon, acronyms, slang can disorient the message for those who do not understand them.
**Tips**

**Tips to develop communication skills**

- Use proper language—avoid jargon, acronyms, slang.
- Listen and do not interrupt the speaker.
- Avoid distractions. For example, taking personal calls at work, talking to co-workers while interacting with supervisor.
- Ask effective questions if the message is not clear.
- Restate the issue or question to verify understanding.
- Follow instructions promptly and appropriately.
- Request advice and feedback.
- Listen effectively.
- Use appropriate body language.
- Make eye contact.
- Nod and smile to acknowledge points.
- Allow the person to speak, without thinking about what you’ll say next.

**Ask**

- Ask about importance of positive attitude.
- Ask about how to impart positive attitude.

**Team Activity**

- Ask the students to assemble together.
- Explain the purpose and duration of the activity.
- Set guidelines pertaining to discipline and expected tasks.

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<thead>
<tr>
<th>Skill Practice</th>
<th>Time</th>
<th>Resources</th>
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<tbody>
<tr>
<td>Effective communication between 2 persons</td>
<td>1 hour</td>
<td>Communication tools</td>
</tr>
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</table>
**Do**

- Ask them to get into pairs for practice and do some casual conversation.
- Go around and make sure they are doing it properly.

**Notes for Facilitation**

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the exercise at the end of the unit.
- Explain the exercise and ensure that every participant is doing the exercise.
At the end of this unit, you will be able to:

1. Explain what are problem solving skills;
2. Solve your problems efficiently;

**Unit Objectives**

**Resources to be Used**

- Available objects such as whiteboard, white board marker pens, duster, participant manual.
- PC with LCD Projector or Flip Chart

**Do**

- Welcome and greet the participants. Revise the learnings of the previous sessions and ask them if they have any doubts.

**Say**

- Problems are predictable. How a person sees a problem, speaks a lot about his/her personality.
- Most of us are too concerned about the magnitude of the problem and intensity of its consequences. A good problem solver needs skills that might not come naturally.
- Problem solving is a process by which a person uses his/her skills, knowledge and understanding to face situation that’s not pleasant or familiar.
- How you handle the problem and find the right solution can affect the success of your work.
- The best way to solve a problem is to prevent it by being careful and analytical.
Why problem solving skills required at work

**Let’s understand with an example** – A welder who had a really bad day. When he starts from home, he misses the bus. As he waits for the next bus, he reaches late on the work. His manager will get angry and gives him a feedback in front of others. Now he is sad and feels embarrassed. After sometime machine stops working and his complete day gets wasted.

So what he has to do now? He has to start crying or he has to learn from problems and prevent further losses.

It’s really important to be rational and mature to stay happy and prevent losses from problems. Thus problem solving skills need to be acquired to be successful in any profession.

**How to solve problems**

1. Recognize the problems
   - Identify what is wrong
   - List the problem
   - Speak with others

2. Analyze it
   - What is the issue?
   - Why did it happen?
   - When did it get noticed?
   - Who is going to be affected by it?
   - Where will the affect be?
   - How significant is the problem?

3. Set goals
   - What do I want?
   - What is the current state and what is the desired state?
   - What are the steps that I should take to resolve the issue?
   - Are the steps being finished on time set by you?
   - What is getting in my way of reaching the desired outcome?

4. Evaluate potential solutions
   - Find the options that will solve the problem.
   - Think about the positives and negatives of each option.
• List all the pros and cons of each option.
• The best solution is one which has more positives than negatives.

5. Refine the best solution and apply it.
• Find the best solution.
• Apply the best solution.

6. Evaluate the applied solution
• Was my solution the best one?
• Did I have a better way of solving the issue?
• Did I judge the problem correctly?
• Could I stop the loss?
• Can I apply this solution next time for similar problem?

Personality traits of a problem solver
• Good communication skills
• Good analyzing skills
• Wisdom and knowledge about the problem
• Good interpersonal skills
• Be positive
• Know the value of time
• Be a quick learner
• Be risk taker
• Respect other’s point of view
• Use your own judgement and not get influenced by others
• Be confident
• Think and act!
Ask

- Ask about need of problem solving skills
- Ask about process of solving problems
- Ask about personal traits required for problem solving skills

Notes for Facilitation

- Summarize the main points.
- Ask participants if they have any doubts.
- Encourage them to ask questions.
- Answer their queries satisfactorily.
- Tell participants to complete the exercise at the end of the unit.
- Explain the exercise and ensure that every participant is doing the exercise.
10. Employability & Entrepreneurship Skills

Unit 10.1 – Personal Strengths & Value Systems
Unit 10.2 – Digital Literacy: A Recap
Unit 10.3 – Money Matters
Unit 10.4 – Preparing for Employment & Self Employment
Unit 10.5 – Understanding Entrepreneurship
Unit 10.6 – Preparing to be an Entrepreneur
This Facilitator’s guide includes various activities which will help you as a facilitator to make the sessions participative and interactive.

**Ice breaker**

- You can begin the module with the following ice breaker:

**Five of Anything Ice Breaker Steps:**

- Divide the participants into groups of four or five by having them number off. (You do this because people generally begin a meeting by sitting with the people they already know best.)
- Tell the newly formed groups that their assignment is to share their five favourite movies of all time, their five favourite novels or their five least liked films. The topic can be five of anything - most liked or disliked.
- This ice breaker helps the group explore shared interests more broadly and sparks lots of discussion about why each person likes or dislikes their selected five.
- Tell the groups that one person must take notes and be ready to share the highlights of their group discussion with the class upon completion of the assignment.

**Expectation Mapping**

1. During the first session and after ice breaker session, ask the participants to answer the following question: "What do I expect to learn from this training?"
2. Have one of the participants write their contributions on a flip chart sheet.
3. Write down your own list of covered material in the training on another flip chart sheet.
4. Compare the two sheets, commenting on what will and what will not be covered during the training.
5. Set some ground rules for the training sessions. Ask the participants to put these rules on a flipchart and display it in the class.
6. You may get back to those sheets once again at the end of the last session of the training.
7. Benefits of doing this activity:
   - Participants feel better as their opinions are heard.
   - Participants get to know what they should expect from the training.
   - The facilitator gets to know which points to emphasize, which to leave out, and which to add during the training.
8. Expectations from the participants:
   - Must sign the attendance sheet when they arrive for class.
   - Conduct themselves in a positive manner
   - Be punctual, attentive, and participative
9. Explain the contents that are going to get covered one by one and connect it with the expectation mapping done earlier.
10. By the end of this exercise, the participants should have a clear understanding of what to expect from the session and what are the areas that will not get covered.

**Defining Objectives**

1. Defining the objectives in the beginning of the units sets the mood for the unit.
2. To begin with the end in mind sets the expectations of the participants as what could be the important takeaways from the session.
3. It is also a way of making participants take responsibility of their own learning process.
4. For the facilitator, the objectives decide a designed path to progress on so that the learning stays aligned and on track.
5. Read the objectives slowly, one by one, and ask the participants to explain what they think it means.
6. At the end of the session, you could again revisit the objectives to find out from the participants about how many objectives have been achieved.

In order to effectively facilitate this workshop:

1. You must have thorough knowledge of the material in the Participant Handbook, and be prepared to answer questions about it.
2. You may also wish to read other material to enhance your knowledge of the subject.
3. There may be issues raised with which you are not able to deal, either because of lack of time or knowledge. You can either state that you will obtain answers and get back to the participants with the information. Incase the query can be turned to an assignment to the class, do so. You can work with the the participants on the assignenment.
4. You must have a very clear understanding of what the participants want to accomplish by the end of the workshop and the means to guide the participants.
5. As the facilitator, it is your responsibility to make sure that all logistical arrangements are made for the workshop. This may involve doing it yourself or confirming that someone else has made all necessary arrangements associated with the workshop. Assume nothing and check everything before the workshop begins.
6. To break the monotony and boredom during sessions, introduce mini breaks in the form of stretching exercises, jokes, some group songs or games.
7. Invite discussion from the participants.
8. Probe the participants further and lead them to come to affirmative conclusions.
9. Let the participants answer. No answer is incorrect.
10. Ask one participant to write all the points on the whiteboard.
11. Build the sessions from the answers provided by the class.
12. Prepare for the sessions in advance so that the resources like flipcharts, handouts, blank sheets of paper, marker pens, etc. can be kept ready.
13. Ensure that resources like board, markers, duster etc. is available before your session starts.

General instructions for role playing:

1. You are not being asked to be an actor or to entertain. The purpose of the role play is to provide a situation in which you can practice certain skills.
2. When you read the brief, try to imagine yourself in the situation described and behave in a way you feel to be natural – but be conscious of the fact that your role may require a different approach from that which you might normally use.
3. You (and others) may benefit from the change in approach and behaviour. Therefore, try to use the approach you feel to be most appropriate for the circumstances described in your brief.
4. The brief is just the starting point. It simply sets the scene and the tone of session or activity. Try not to keep referring to the brief as this will affect the spontaneity of the meeting. Allow the role play to develop as you think it might in real life and change your reactions in line with the behaviour and responses of others involved.
5. If you find that you have too little information to answer questions or to describe what has happened in the situation, do feel free to add your own thoughts and ideas. Try to keep these within the framework of the role you are taking and try to make your improvisations as realistic as possible.
UNIT 10.1: Personal Strengths & Value Systems

Key Learning Outcomes

At the end of this unit, participants will be able to:
1. Explain the meaning of health
2. List common health issues
3. Discuss tips to prevent common health issues
4. Explain the meaning of hygiene
5. Discuss the purpose of Swacch Bharat Abhiyan
6. Explain the meaning of habit
7. Discuss ways to set up a safe work environment
8. Discuss critical safety habits to be followed by employees
9. Explain the importance of self-analysis
10. Discuss motivation with the help of Maslow’s Hierarchy of Needs
11. Discuss the meaning of achievement motivation
12. List the characteristics of entrepreneurs with achievement motivation
13. List the different factors that motivate you
14. Discuss the role of attitude in self-analysis
15. Discuss how to maintain a positive attitude
16. List your strengths and weaknesses
17. Discuss the qualities of honest people
18. Describe the importance of honesty in entrepreneurs
19. Discuss the elements of a strong work ethic
20. Discuss how to foster a good work ethic
21. List the characteristics of highly creative people
22. List the characteristics of highly innovative people
23. Discuss the benefits of time management
24. List the traits of effective time managers
25. Describe effective time management technique
26. Discuss the importance of anger management
27. Describe anger management strategies
28. Discuss tips for anger management
29. Discuss the causes of stress
30. Discuss the symptoms of stress
31. Discuss tips for stress management
UNIT 10.1.1: Health, Habits, Hygiene: What is Health?

Unit Objectives
At the end of this unit, participants will be able to:
• Explain the meaning of health
• List common health issues
• Discuss tips to prevent common health issues
• Explain the meaning of hygiene
• Discuss the purpose of Swachh Bharat Abhiyan
• Explain the meaning of habit

Resources to be Used
• Participant Handbook

Ask
• What do you understand by the term “Health?”
• According to you, who is a healthy person?

Say
• Discuss the meaning of health and a healthy person as given in the Participant Handbook.

Ask
• When did you visit the doctor last? Was it for you or for a family member?

Say
• Discuss the common health issues like common cold, allergies etc. Refer to the Participant Handbook.
• Let us do a small activity. I will need some volunteers.

Role Play
• Conduct a small skit with volunteers from the class. Consider one of the villagers has been appointed as a health representative of the village, what measures will you as a health representative suggest to the common villagers to prevent common health issues discussed.
• You will need at least 4 volunteers (Narrator, Health Representative, Head of the Village, Doctor).
• Explain the health concerns of the village to the Narrator. The Narrator will brief the class about the skit.
• Give the group of volunteers, 5 minutes to do discuss.
• At the end of 5 minutes, ask the group to present the skit to the class assuming them as the villagers.
• The class can ask questions to the group as a common villager.

Summarize
• Through this activity we got some tips on how can we prevent these common health issues.
Say

- Let us now see how many of these health standards we follow in our daily life.

Activity

- Health Standard Checklist from the Participant Handbook.

Ask

- How many of you think that you are healthy? How many of you follow healthy habits?

Say

- Let’s do an exercise to find out how healthy you are.
- Open your Participant Handbook section ‘Health, Habits, Hygiene: What is Health?’ and read through the health standards given.
- Tick the points which you think are true for you.
- Try to be as honest as possible as this test is for your own learning.

Do

- Ensure that all the participants have opened the right page in the Participant Handbook.
- Read aloud the points for the participants and explain if required.
- Give them 5 minutes to do the exercise.
- At the end of 5 minutes, ask the participants to check how many ticks have they got.

Summarize

- Tell them that they need to follow all the tips given in this checklist regularly in order to remain healthy and fit.

Ask

Discuss:
- Is it necessary to practice personal hygiene every day? Why?
- How does a person feel when they do not practice good personal hygiene? Why?
- Can good personal hygiene help a person feel good about his/her self? How?

Say

- Discuss the meaning of hygiene as given in the Participant Handbook.

Activity

- Health Standard Checklist: Hygiene
Say

- Let’s do an exercise to find out if we maintain good hygiene habits or not.
- Open the Participant Handbook and read through the Health Standard checklist given.
- Tick the points which you think are true for you.
- Try to be as honest as possible as this test is for your own learning.

Do

- Ensure that all the participants have opened the right page in the Participant Handbook.
- Read aloud the points for the participants and explain if required.
- Give them 5 minutes to do the exercise.
- At the end of 5 minutes, ask the participants to check how many ticks have they got.
- Ask them to calculate their score.
- Tell them what each score indicates by reading aloud what has been mentioned in the Participant Handbook.

Ask

- How many of you have heard about “Swachh Bharat Abhiyan”?
- Can you tell the class what it is about?

Summarize

- Tell them about Swachh Bharat Abhiyan as given in the Participant Handbook and request them to take a pledge to keep our country clean.

Ask

- What is a habit?

Say

- Discuss some good habits which can become a way of life.

Summarize

- Tell them about good and bad habits and the reasons to make good habits a way of life.
UNIT 10.1.2: Safety

Unit Objectives
At the end of this unit, participants will be able to:
• Discuss ways to set up a safe work environment
• Discuss critical safety habits to be followed by employees

Resources to be Used
• Participant Handbook
• Safety signs and symbols
• Safety equipments
• Blank papers
• Pens

Say
• There are many common safety hazards present in most workplaces at one time or another. They include unsafe conditions that can cause injury, illness and death.
• Safety Hazards include:
  • Spills on floors or tripping hazards, such as blocked aisles or cords running across the floor.
  • Working from heights, including ladders, scaffolds, roofs, or any raised work area.
  • Unguarded machinery and moving machinery parts; guards removed or moving parts that a worker can accidentally touch.
  • Electrical hazards like cords, missing ground pins, improper wiring.
  • Machinery-related hazards (lockout/tag out, boiler safety, forklifts, etc.)

Team Activity
Safety Hazards
• There are two parts to this activity.
• First part will cover the potential safety hazards at work place.
• Second part will cover a few safety signs, symbols and equipments at work place.
• Use this format for the first part of the activity.

<table>
<thead>
<tr>
<th>PART 1</th>
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<tr>
<td>Hazard</td>
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Ask
• How could you or your employees get hurt at work?
Let's understand it better with the help of an activity. You will be given a handout within your groups. You have to think about the possible hazards of your workplace, what damage these hazards could cause and about the corrective action.

Divide the class into five to six groups of four participants each.
Put the format on the board for the activity.
Give blank papers and pens to each group.
The group is expected to think and discuss the potential safety hazards in the workplace.
Ask the group to discuss and fill the format using the blank sheet.
Give the groups 5 minutes for the activity.
For the second part of the activity, show the class some pictures of safety signs, symbols and equipments.
Now they will put down a few safety symbols, signs or equipment against the safety hazards identified.
Give them 5 to 10 minutes to discuss and draw/NOTE it.
At the end of 10 minutes the groups will present their answers to the class.

Now, let's discuss the answers with the class.
All the groups will briefly present their answers.

Ask the audience to applaud for the group presentation.
Ask de-brief questions to cull out the information from each group.
Keep a check on time.
Tell the group to wind up the discussion quickly if they go beyond the given time limit.

What did you learn from the exercise?
As an entrepreneur, is it important to ensure the safety of your employees from possible hazards? Why?

Ask the participants what they have learnt so far.
Ask if they have any questions related to what they have talked about so far.
Close the discussion by summarizing the tips to design a safe workplace and non-negotiable employee safety habits.
UNIT 10.1.3: Self Analysis - Attitude, Achievement Motivation: What is Self Analysis?

Unit Objectives
At the end of this unit, participants will be able to:
- Explain the importance of self-analysis
- Discuss motivation with the help of Maslow's Hierarchy of Needs
- Discuss the meaning of achievement motivation
- List the characteristics of entrepreneurs with achievement motivation
- List the different factors that motivate you
- Discuss the role of attitude in self-analysis
- Discuss how to maintain a positive attitude
- List your strengths and weaknesses

Resources to be Used
- Participant Handbook
- Old newspapers
- Blank papers
- Pencils/pens

Activity
- This is a paper pencil activity.

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<th>What are the three sentences that describe you the best?</th>
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<tbody>
<tr>
<td>What do you need to live happily?</td>
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<tr>
<td>What are your strengths and weaknesses?</td>
</tr>
</tbody>
</table>

Do
- Write the three questions on the board/flipchart before the session begins.
- Give plain papers and pencils/pens to each participant.
- Tell participants to write the answer for the three questions on the paper.
- Tell them the purpose of this activity is not to judge anyone but to understand more about self.

Say
- Discuss the concept of Self Analysis and motivation with reference to Maslow's Hierarchy of Needs as discussed in the Participant Handbook.

Team Activity
Tower building
- Each group which will create tower using the old newspapers.
Machining and Quality Technician

Do

- Divide the class into groups.
- Give them some old newspapers.
- The task is to create a tower out of the newspapers.
- The group which will create the highest tower standing on its own will be considered the winning group.
- Groups can use as many newspapers as they want to and in any way they want.

Ask

- What did the winning group do differently?
- If you were given a chance, how would you have made the tower differently?
- How did you feel while making the tower?
- Did you feel motivated?

Say

- Discuss the concept of achievement motivation and characteristics of entrepreneurs with achievement motivation as discussed in the Participant Handbook.

Ask

- Is your attitude positive or negative?

Say

- Let me tell you a story:

It’s Little Things that Make a Big Difference.

There was a man taking a morning walk at the beach. He saw that along with the morning tide came hundreds of starfish and when the tide receded, they were left behind and with the morning sun rays, they would die. The tide was fresh and the starfish were alive. The man took a few steps, picked one and threw it into the water. He did that repeatedly. Right behind him there was another person who couldn’t understand what this man was doing. He caught up with him and asked, “What are you doing? There are hundreds of starfish. How many can you help? What difference does it make?” This man did not reply, took two more steps, picked up another one, threw it into the water, and said, “It makes a difference to this one.” What difference are we making? Big or small, it does not matter. If everyone made a small difference, we’d end up with a big difference, wouldn’t we?

Ask

- What did you learn from this story?

Activity

What Motivates You?

- This is an individual activity.
- It is an exercise given in the Participant Handbook.

Do

- Ask the class to open their Participant Handbook and complete the exercise given in the section What Motivates You?
- Ensure that the participants have opened the correct page for the activity.
- Give the class 5 minutes to complete the activity.
Say

- Discuss the concept of attitude and how to cultivate a positive attitude as discussed in the Participant Handbook.

Summarize

- Close the discussion by summarizing how self-analysis, knowledge about what motivates you and your positive attitude can help in your business as well in life.
UNIT 10.1.4: Honesty & Work Ethics

Unit Objectives
At the end of this unit, participants will be able to:
- Discuss the qualities of honest people
- Describe the importance of honesty in entrepreneurs
- Discuss the elements of a strong work ethic
- Discuss how to foster a good work ethic

Resources to be Used
- Participant Handbook

Ask
- What do you understand by honesty?
- Why is it important for entrepreneurs to be honest?
- Do you remember any incident where your honesty helped you in gaining confidence?
- Do you remember any incident where someone lost business due to dishonesty?

Say
- Talk about honesty, qualities of an honest person, and the importance of honesty in entrepreneurs as discussed in the Participant Handbook.
- “Let’s understand it better with the help of some case scenarios. You will be given some cases within your groups. You have to analyse the case scenario that has been given to you and then find an appropriate solution to the problem.
- Keep your discussion focussed around the following:
  - What went wrong?
  - Who was at fault?
  - Whom did it impact - the customer or the businessman?
  - How would it impact the business immediately? What would be the long term impact?
  - What could be done?
  - What did you learn from the exercise?

Do
- Divide the class into four groups of maximum six participants depending on the batch size.
- Give one case study to each group.
- Instruct them to read the case carefully.
- Put down the de-brief questions on the board and ask the groups to focus their discussion around these questions.
- The group is expected to analyse and discuss the case amongst them and find a solution to the given problem. Give the class 5-10 minutes to discuss the case and note down their solutions.
- At the end of 10 minutes the team should present their case solution to the class. The presentation can be a narration or a role play.
- Ask the group to select a group leader for their group. The group leader to discuss and assign roles to the group members for the presentation.
Case Study Analysis

Scenario 1
Aakash has a small mobile retail sales and repair shop in Allahabad. He has one of the most popular outlets and has great rapport with his customers.

It’s around 11 AM when a customer barges in to the shop and starts shouting at Aakash for giving her a faulty instrument. The screen of her mobile is cracked from one side. Aakash remembered thoroughly checking the handset before handing it over to the customer. The customer threatens to sue him and to go to Consumer Court for cheating her. Now, the problem occurred somewhere outside the shop but as other customers were listening to the conversation, it might impact his business. The situation needs to be managed very sensitively. What would you do if you were in Aakash’s place?

Scenario 2
Rajni does beautiful Phulkari embroidery on suits and sarees. She has a small home-based business. She has a huge list of customers on Facebook and WhatsApp who give her orders regularly. Smita is one of her old and regular customers. As her sister-in-law’s wedding was around the corner, Smita wanted to buy few handcrafted Phulkari duppatta. She placed an order for three duppattas via WhatsApp and requested Rajni to send them as soon as possible. When the parcel reached Smita through courier she found that out of the three duppattas, only one was hand embroidered and the other two had machine embroidery on them. Even the length and the quality of the material was not as desired. Smita was heartbroken. It was a complete waste of money and moreover she couldn’t wear what she had planned to during the wedding functions. She sent a message to Rajni on WhatsApp, expressing her anger and disappointment.

Smita has also sent a feedback and expressed her disappointment on the social media... this will directly affect Rajni’s business. What would you do if you were in Rajni’s place?

Scenario 3
Shankar is a tattoo artist who has a small tattoo showroom in a big, reputed mall in New Delhi. Mr Saksham had an appointment for today, at 11:00 am but he reached at 11:50 am. Meanwhile, Shankar had to reschedule his next appointment. After availing Shankar’s services, Mr Saksham started yelling in an abusive language, refusing to pay the requisite amount, and finding faults in the services provided by him. Who was at fault in this case? What should Shankar do? Should he confront Saksham or give in to the demands of the client?

Scenario 4
Shailender is an online cloth reseller who does business through social networking sites such as Facebook and WhatsApp. Priyanka made online payment for a dress to Shailander. But she did not receive the dress for a month. When she asked for a cancellation, Shailander started misleading her. For almost 45 days, he kept promising her that he will pay the amount today, tomorrow, day after etc. Even after repeated calls and messages when she did not receive the payment or the dress, she decided to write a post against him on a popular social media platform. As a result, Shailender lost lots of customers and his flourishing business faced a major crisis. How could this situation have been managed?

Say

• Now, let’s discuss the problem and solution with the larger group.
• The group will first briefly describe the case to the class.
• Then discuss the issue identified and the proposed solution.
• Once the presentation is over, the class can ask their questions.
Do

- Congratulate each group for the group presentation.
- Ask the audience to applaud for them.
- Ask de-brief questions to cull out the information from each group.
- Keep a check on time. Tell the group to wind up the discussion quickly if they go beyond the given time limit.

Summarize

- Ask the participants what they have learnt from the exercise/activity.
- Ask if they have any questions related to what they have talked about so far.
- Close the discussion by summarizing the importance of honesty and work ethics for entrepreneurs.
UNIT 10.1.5: Creativity and Innovation

Unit Objectives

At the end of this unit, participants will be able to:

- List the characteristics of highly creative people
- List the characteristics of highly innovative people

Resources to be Used

- Participant Handbook
- Chart papers
- Marker pens

Ask

- You must be aware of the term 'Rags to riches' and heard stories related to the term.
- What do these stories tell us?
- What was so special about these people?

Say

- Let’s have a look at these stories.
- There are some inspiring stories about people which I would like to share with you.
- Narrate these stories to the class.

A.P.J. Abdul Kalam

Who has not heard of A.P.J. Abdul Kalam: Avul Pakir Jainulabdeen Abdul Kalam hailed from a very humble background. His father was a boat owner. To help his family, Kalam would work as a newspaper vendor. With limited resources, he graduated in Physics and studied aerospace engineering. He was instrumental in India’s step towards nuclear energy. In 2002, he became the 11th President of India.

Water filter/purifier at source

Two young boys studying in classes 4 and 5, from Lingzya Junior High School, Sikkim designed a simple innovative low cost water purifier.

Inspiration behind the idea: Most people today prefer to use a water filter/purifier at their home.

Both the children have given idea to have filter/purifier at the source of water so that everyone has access to clean water without having to make an investment in purchasing a filter/purifier.

Soring’s idea is to have a centralised purification system at the point of distribution like water tank while Subash’s idea is to have such purifiers attached to public taps.


Solar seeder

This is a story of a innovative solar seeder and developed by Subash Chandra Bose, a class 8, student from St Sebasthiyar Matriculation School, Pudukkottai, Tamil Nadu. Subash has developed a solar powered seed drill, which can undertake plantation for different size of seeds at variable depth and space between two seeds.

Looms for physically challenged

Now this is really inspiring of two sisters, Elakkiya a Class 6 student and Pavithra a Class 9 student of SRC Memorial Matriculation, Erode, Tamil Nadu.

The two sisters have come up with loom for lower limbed physically challenged. In their loom they have replaced the pedal operated system with a motor and a gearbox attached to a pulley mechanism.


Ask

- If they can, why can't you?
- Discuss concepts related to 'Creativity and Innovation' with the participants as given in the Participant Handbook.

Say

- Recall the stories on motivation.
- What is the inner drive that motivates people to succeed?
- Let’s learn more about such creative and innovative entrepreneurs with the help of an activity.

Team Activity

- This is a group activity.
  - Think of any one famous entrepreneur and write a few lines about him or her.

Activity De-brief

- Why did you choose this particular entrepreneur?
- What is his/her brand name?
- What creativity does he/she possess?
- What was innovative about their ideas?

Do

- Instruct the participants that this is group work.
- Divide the class into small groups of 4 or 6 depending on the batch size.
- Give each group a chart paper.
- Tell the participants they have to write a few lines about any one famous entrepreneur.
- Give the participants 10 minutes to discuss and write.
- Keep a check on time. Tell the group to wind up quickly if they go beyond the given time limit.
- Ask each group to read out what they have written.
- Ask the de-brief questions.
Summarize

- Summarize the unit by asking participants if they know of some people who are highly creative and innovative in their approach.
- Ask them to share some experiences about these people with the class.

Notes for Facilitation

- Source for stories on innovations:
UNIT 10.1.6: Time Management

Unit Objectives

At the end of this unit, participants will be able to:

- Discuss the benefits of time management
- List the traits of effective time managers
- Describe effective time management techniques

Resources to be Used

- Participant Handbook

Ask

Does this sound like you?

- I can never get enough time to finish what I am doing in a day.
- I have so many things to do that I get confused.
- I want to go for a walk and exercise, but I just do not have the time.
- I had so much to do, so I could not deliver that order on time.
- I would love to start my dream business; but, I just do not have the time.

Example

- Let’s look at these two examples:

Example 1:
Ankita works from home as a freelance writer. She says she can easily put in 8 hours of dedicated work in a day. Because she works from home, she saves money on travel and has a comfortable work routine. But there is a challenge and it is distraction. As she works from home, she can easily just get up and sit down on the sofa to watch TV, wasting valuable time. She may have chores to do, errands to run and bills to pay. She ends up working only two to three hours a day and the result is, her work gets piled up. She is unable to take on more work due to this. Even though her quality of work is appreciated her clients are not very happy about the delay in submission.

Example 2:
Javed has started a successful online selling company from home and makes a good living from his sales. He has set up a small office space in his living room. As both his parents are working full-time, he also has the role of taking care of his two younger siblings. He almost spends half of his day with the younger kids. He does not mind it but it means taking time away from the work. He is still able to manage his online business with these commitments. He wants to spend some more dedicated hours so as to increase his profits. He also wants to look into new business avenues. What should he be doing.

Ask

- Does this happen with you too?
- Do you find it difficult to prioritize your work?
- Are you able to manage your time effectively?
Activity

- Conduct a group discussion based on the above examples.
- Direct the discussion on how to prioritize work and manage time effectively.

Say

- Time management is not only about how hard you work but also about how smart you work.
- Discuss “What is Time Management” with the participants as given in the Participant Handbook.

Ask

- Why is it important to manage time? How does it help?
- What happens when you don’t manage your time effectively?
- Do you find it difficult to prioritize your work?

Say

- Discuss the benefits of time management given in the Participant Handbook.
- Let’s learn effective time management with the help of an activity.

Activity

**Effective Time Management**

- This activity has two parts:

**PART 1**

**TO-DO LIST**

- You have to make a to-do list.
- List all of the activities/tasks that you have to do.
- Try to include everything that takes up your time, however unimportant it may be.
- If they are large tasks, break them into action steps, and write this down with the larger task.
- You can make one list for all your tasks or have separate to-do lists for personal and professional tasks.

**PART 2**

**URGENT-IMPORTANT GRID**

- You have to make a grid as shown on the board here.
- This grid has four boxes. As you can see, each box has a different heading.
- At the heart of the urgent-important grid, are these two questions:
  - Is this task important?
  - Is this task urgent?
- Now, you have to think about each activity that you have written in your to-do list and put it into one of the four categories.
  - **What do these categories depict?**
  - **Category 1: Urgent/Important**
    - This category is for the highest priority tasks. They need to get done now.
• **Category 2: Not Urgent/Important**
  • This is where you want to spend most of your time.
  • This category allows you to work on something important and have the time to do it properly.
  • This will help you produce high quality work in an efficient manner.
  • The tasks in this category are probably the most neglected ones, but also the most crucial ones for success.
  • The tasks in this category can include strategic thinking, deciding on goals or general direction and planning—all vital parts of running a successful business.

• **Category 3: Urgent/Not Important**
  • This is where you are busy but not productive. These tasks are often mistaken to be important, when they’re most often busywork.
  • Urgent but not important tasks are things that prevent you from achieving your goals.
  • However, some may be activities that other people want you to do.

• **Category 4: Not Important and Not Urgent**
  • This category doesn’t really include tasks, but rather habits that provide comfort, and a refuge from being disciplined and rigorous with your time management.
  • Some may be activities that other people want you to do.
  • These might include unplanned leisure activities as well.

**TO-DO list format**

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### URGENT-IMPORTANT GRID

#### URGENT/ IMPORTANT
- Meetings
- Last minute demands
- Project deadlines
- Crisis

#### NOT URGENT/ IMPORTANT
- Planning
- Working towards goals
- Building relationship
- Personal commitments

#### URGENT/ NOT IMPORTANT
- Interruptions
- Phone calls/ E-mails
- Other people's minor demands

#### NOT URGENT/ NOT IMPORTANT
- Internet surfing
- Social media
- Watching TV

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**URGENT/ IMPORTANT GRID format**

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Do

- Put down the formats for the to-do list and the urgent/important grid on the board.
- Instruct the participants to prepare their to-do list first.
- Give the participants 10 minutes to prepare the list.
- Once done, instruct them to divide the tasks in to-do list into the four categories.
- Explain the four categories to the participants giving examples specific to their context.
- As you explain the categories fill the grid with the type of tasks.
- Give the participants 40 minutes to fill the grid.
- Then explain how to balance the tasks between the four categories.
- Keep a check on time. Tell the group to wind up quickly if they go beyond the given time limit.

Say

Activity De-brief:

How can we balance tasks between the four categories?

How to manage time through this grid?

- **Category 1: Urgent/Important**
  - Try to keep as few tasks as possible here, with the aim to eliminate.
  - If you spend too much of your time in this category, you are working solely as a trouble shooter, and never finding time to work on longer-term plans.

- **Category 2: Not Urgent/Important**
  - Plan these tasks carefully and efficiently as they are most crucial ones for success.
  - If necessary, also plan where you will do these tasks, so that you're free from interruptions.
  - Include strategic thinking, deciding on goals or general direction and planning in your planning process.

- **Category 3: Urgent/Not Important**
  - Ask yourself whether you can reschedule or delegate them.
  - A common source of such activities is other people. Sometimes it’s appropriate to say "no" to people politely, or to encourage them to solve the problem themselves.

- **Category 4: Not Important and Not Urgent**
  - You also want to minimize the tasks that you have in this category.
  - These activities are just a distraction – avoid them if possible.
  - You can simply ignore or cancel many of them.
  - Politely say "no" to work assigned by others, if you can, and explain why you cannot do it.
  - Schedule your leisure activities carefully so that they don't have an impact on other important tasks.
  - Discuss the traits of effective time managers and effective time management techniques as given in the Participant Handbook.

Summarize

- Discuss the traits of effective time managers and effective time management techniques as given in the Participant Handbook.
Notes for Facilitation

- Here is a short story. You can conclude the session narrating the story. To make it more interesting you can perform the demonstration described and discuss the short story.

- One day an expert in time management was speaking to a group of students. As he stood in front of the group, he pulled out a large wide-mouthed glass jar and set it on the table in front of him. Then he took out a bag of about a dozen rocks and placed them, one at a time, into the jar. When the jar was filled to the top and no more rocks would fit inside, he asked, "Is this jar full?" Everyone in the class said, "Yes." Then he said, "Really?"

- He reached under the table and pulled out a bucket of gravel (small stones). He dumped some gravel in and shook the jar causing pieces of gravel to work themselves down into the space between the rocks. Then he asked the group once more, "Is the jar full?" By this time, the class began to understand. "Probably not," one of them answered. "Good!" he replied.

- He reached under the table and brought out a bucket of sand. He started dumping the sand in the jar and it went into all of the spaces left between the rocks and the gravel. Once more he asked the question, "Is this jar full?" No!" the class shouted. Once again he said, "Good." Then he grabbed a jug of water and began to pour it in until the jar was filled to the brim. Then he looked at the class and asked, "What is the point of this illustration? "One student raised his hand and said, "No matter how full your schedule is, if you try really hard you can always fit some more things in it!" "No," the speaker replied, "that’s not the point. The truth this illustration teaches us is: If you don’t put the big rocks in first, you’ll never get them in at all." What are the 'big rocks' in your life? Your children; your loved ones; your education; your dreams; a worthy cause; teaching or mentoring others; doing things that you love; time for yourself; your health; your mate (or significant other). Remember to put these BIG ROCKS in first or you’ll never get them in at all. If you sweat about the little stuff (the gravel, sand, and water) then you’ll fill your life with little things you worry about that don’t really matter, and you’ll never have the time you need to spend on the big, important stuff (the big rocks).

- End the story with these lines...

So, tonight, or in the morning tomorrow, when you are reflecting on this short story, ask yourself this question: What are the 'big rocks' in my life? Then, put those in your jar first.
UNIT 10.1.7: Anger Management

Unit Objectives
At the end of this unit, participants will be able to:
• Discuss the importance of anger management
• Describe anger management strategies
• Discuss tips for anger management

Resources to be Used
• Participant Handbook

Ask
• What is anger? Is anger good or bad?
• Is anger normal or an abnormal behaviour? How can anger harm you?
• Why is it important for entrepreneurs to manage their anger?

Say
• Talk about anger and the importance of anger management in entrepreneurs as discussed in the Participant Handbook.
• Let us do a small activity. This is an individual activity.
• Think of the incidents and situations that angered you and hurt you.

Do
• Instruct them to note down these situations under different categories (as given in the Activity).
• Give the class 3-5 minutes to think and note down their answers.
• At the end of 5 minutes, ask some participants to volunteer and present their answers.
• They can also share these situations with their fellow participants if they do not wish to share it with the entire class.

Activity
• Do you remember any incident which has hurt
  • you physically
  • you mentally
  • your career
  • your relationships.

Ask
• Do you ever get angry?
• What are the things that make you angry?
• Do you remember any incident where your anger management helped you in maintaining healthy relationship?
• Do you remember any incident where someone lost business/ friend/ relationship due to temper (anger)?
There are a few strategies which can help in controlling your anger. Let’s do an activity to understand the anger management process better.

This is an individual activity.

Think of the incidents/ situations which trigger your anger (the cause).

Then think what happened as a result of your anger (the effect).

You need to come up with some techniques to manage your anger.

- Give the class the anger triggers (the cause) as listed in the activity.
- Put down the activity format (Anger Triggers, Result of your Anger, Anger Management Techniques) on the board and instruct the class to write the answers under different categories.
- Give the class 3-5 minutes to think and note down their answers.
- At the end of 5 minutes, ask the participants who wish to volunteer and present their answers.

### List of triggers that make you angry:

- Someone says you did something wrong.
- You want something you can't have now.
- You get caught doing something you shouldn't have been doing.
- You are accused of doing something you didn't do.
- You are told that you can't do something.
- Someone doesn't agree with you.
- Someone doesn't do what you tell him to do.
- Someone unexpected happens that messes up your schedule.

### Result of your anger:
Write the techniques that you use to manage your anger:

| Anger Management Techniques |

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**Say**

- Now, let’s discuss the problems and solution with all.
- The individual will first briefly describe trigger points to the class.
- Then discuss the result of the anger. Other participants are requested to remain quiet while one is making the presentation.
- Post presentation, other participants may ask questions.

**Do**

- Congratulate each individual for sharing their points.
- Ask the audience to applaud for them.
- Ask de-brief questions after the presentation to the class.
- Keep a check on the time. Ask the participants to wind up the activity quickly if they go beyond the given time limit.

**Ask**

**De-brief questions:**

- In the situation described by the presenter, who was at fault?
- How could you have handled this situation alternatively?

**Summarize**

- Close the discussion by summarizing the strategies and tips of anger management for entrepreneurs.
- Ask the participants what have they learnt from this exercise/activity.
- Ask if they have any questions related to what they have talked about so far.

**Notes for Facilitation**

- Encourage the participants to share information about them while presenting the situations to the class.
- Keep the format of the Activity prepared in a chart paper so that it can be displayed during the session.
At the end of this unit, participants will be able to:

- Discuss the causes of stress
- Discuss the symptoms of stress
- Discuss tips for stress management

**Unit Objectives**

**Resources to be Used**

- Participant Handbook

**Ask**

- You are waiting in the reception for an interview or a very important meeting, suddenly your legs are shaky, your hands are cold, you are feeling nervous. Have you ever been in this kind of situation?
- Have you had days when you had trouble sleeping?
- Have you ever been so worried about something that you ended up with a terrible headache?

**Say**

- You’ve probably heard people say, I’m really stressed out” or "This is making me totally stressed.”

**Ask**

- What do you understand by stress?
- What gives you stress?
- How do you feel when you are stressed or what are the symptoms of stress?
- How can stress harm you?
- Why is it important for entrepreneurs to manage stress?

**Say**

- When we feel overloaded or unsure of our ability to deal with certain challenges, we feel stressed.
- Discuss about stress, causes of stress, and symptoms of stress as discussed in the Participant Handbook.
- Let’s understand the causes of stress and how to deal with them with the help of some case scenarios.
- You will be given some cases.
- You have to analyse the case scenario and then find an appropriate solution to the problem.
- This will be a group activity.

**Do**

- Divide the class into four groups of 5-6 participants (depending on the batch size).
- Assign one case scenario to each group.
- Instruct them to read the case carefully.
- The group is expected to analyse and discuss the case amongst them and find a solution to the given problem.
- Explain their discussion should result in getting answers for the following questions:
Case Study Analysis

Scenario 1
Akash's alarm doesn't go off and he gets late getting out of the house. He hits traffic and ends up 15 minutes late to work, which his boss notices. He gets to his desk and finds he has to complete 2 reports in next one hour. Just when he is about to begin work, a message pops up “Telecon with the client begins in 10 minutes. Please be in the conference room in 5 minutes.”

His is not prepared for the call. He is stressed. He does not want to speak to his boss about this. He is stressed, feeling uncomfortable and sick. Not in a position to attend the call or finish the reports on time.

Scenario 2
While paying his overdue bills, Rahul realised that it’s the middle of the month and he has only Rs 500 left in his account. He has already asked all of his friends, and family for loans, which he hasn't paid back yet. He is still contemplating over the issue when his phone rings. His sister’s birthday is due next week and she has seen a beautiful dress which she wants to buy but cannot tell the parents as it is a bit expensive. She wishes if Rahul could buy the dress for her. Rahul has promised to buy her the dress for her birthday.

Rahul is stressed, does not understand what to do. He is unable to concentrate on his work and unable to complete the tasks assigned. His team leader has already warned him of the delay.

Scenario 3
Sheela calls the cable company as she has unknown charges on her bill. She has to go through the automated voice mail menu three times and still can’t get through to a customer care executive. After 15 minutes of repeated efforts, her call is answered. She explains the entire issue to the customer care executive but before the person could suggest a way out, the call drops.

Now Sheela has to call back and repeat the whole process all over again with a new customer care executive. She is very angry and calls again but cannot connect this time.

She has to leave to office so she decides to call from office and check. When she connects this time she is angry and argues with the executive on the call. All her co-workers around are looking at her as her volume has suddenly increased. She bangs the phone and ends the call.

Her co-worker Neelam enquires what has happened to her. She ignores her and just walks off. She has become irritable and her behaviour and tone with other co-workers is not acceptable.
Scenario 4
Arpit is a young entrepreneur who started doing business through Facebook few weeks back. He had always been into a job. Although Arpit has very few financial liabilities, it wasn't an easy decision to leave a comfortable job at once and look for newer pastures. Arpit's boss warned him of the consequences and the challenges of starting a business when nobody ever in his family had been in business.
He has not been able to get a good deal till now. This is an important life shift for him which comes with unknown variables. Arpit is nervous and is wondering if he has what it takes to fulfill the requirement of his new role, or the new experiences he's likely to face.

Ask
De-brief questions:
• What was/were the cause(s) of stress?
• Was the stress avoidable or manageable under the given circumstances?
• If yes, how do you think that the stress could be avoided (managed)?
• If no, then why not?

Say
• Now, let's discuss the problem and solution with the larger group.
• The group will first briefly describe the case to the class.
• Then discuss the issue identified and the proposed solution.
• Post presentation, the other groups may ask questions to the group that has presented.

Do
• Congratulate each group for sharing their points.
• Ask the audience to applaud for them.
• Ask de-brief questions to cull out the information from each group.
• Keep a check on time. Tell participants to wind up the discussion quickly if they go beyond the given time limit.

Say
• While it is common and normal to feel some tension. This feeling nervous and tensed can interfere with your thinking process and can have a negative impact on your performance.
• Stress can deplete the most vibrant of souls. It can have a negative effect on every aspect of a person's life including their health, emotional well-being, relationships, and career. However, one needs to understand the causes and types of stress before looking for ways to manage it.

De-brief:
Scenario 1
The cause of stress was lack of time management and the habit of procrastinating. If Akash would have managed his time well, planned alternate ways to get up on time, finished prior tasks on time and planned for client meetings in advance then he wouldn't have faced stress.
Scenario 2
The cause of stress was lack of financial planning. Rahul should have planned his financial resources well in advance and saved some money for the rainy day. Also, differentiating between needs and wants and keeping a check on non-essential expenditure would have saved Rahul from this situation.

Scenario 3
Sometimes, stress is caused due to external factors instead of internal ones. In this case, the stress was unavoidable because we have no control over this customer care system. Every time, you will get in touch with a new executive and will have to explain all over again. This might cause stress but despite being frustrated and angry there is little that we can do about it. All Sheela could do was to find ways to calm herself down through some breathing exercises and meditation, reading some good book or listening to music and then start afresh.

Scenario 4
A positive, major life change can be a source of good stress. Regardless of how good the change is, it can be stressful. Stress caused by a positive and major life change can be beneficial because it causes a person to step out of their comfort zone and learn new skills. Here, Arpit may become a successful entrepreneur or learn new ways to do things differently.

Now let us see this scenario, can I have a volunteer to read out this case to the class.

Scenario 5
Rakesh lives in Kathmandu with his wife and two beautiful daughters Sarah and Sanya. Nepal was hit by a massive earthquake and Rakesh’s building collapsed during the earthquake. During evacuation, Rakesh realised that though his wife and Sarah were fine and suffered only minor bruises, Sanya was nowhere in the scene. Panic stricken, he started calling her name and searching her frantically. A little later, he heard a meek voice from beneath the debris. He quickly removed the rubble to find a huge bed. Rakesh was pretty sure that Sanya was trapped underneath. Though he was badly bruised, he gathered all his courage and with all his might, he lifted the several-ton bed to save Sanya’s life. Everyone was relieved to see Sanya alive and also extremely surprised to see this father’s ability to access superhuman strength.

• Ask the audience to applaud for the participant after the scenario is read completely.
• Discuss the scenario, ask de-brief questions:
  • What kind of stress was Rakesh undergoing in this case?
  • Was the stress avoidable or manageable under the given circumstances?
  • What was the result of the stress?

De-brief:
• Not all stress is harmful; good stress is actually energizing. This was a case of lifesaving stress, or hero stress, which is an important example of good stress. You may have heard stories in which a person performs an impossible feat of physical strength in order to save their life or the life of someone they love. This type of stress causing a surge of adrenaline is good for us.
Summarize

- Close the discussion by summarizing the tips to manage stress as given in the Participant Handbook.
- Ask the participants what they have learnt from this exercise/activity.
- Ask if they have any questions related to what they have talked about so far.

Notes for Facilitation

- Keep printed copies of the activities/scenarios ready for the session.
- Put down the de-brief questions on a flip chart so that it can be displayed in the class during the activity.
- Encourage participation and make the discussions interactive.
UNIT 10.2: Digital Literacy: A Recap

### Key Learning Outcomes

At the end of this unit, participants will be able to:

1. Identify the basic parts of a computer
2. Identify the basic parts of a keyboard
3. Recall basic computer terminology
4. Recall the functions of basic computer keys
5. Discuss the main applications of MS Office
6. Discuss the benefits of Microsoft Outlook
7. Identify different types of e-commerce
8. List the benefits of e-commerce for retailers and customers
9. Discuss Digital India campaign will help boost e-commerce in India
10. Describe how you will sell a product or service on an e-commerce platform
UNIT 10.2.1: Computer and Internet Basics: Basic Parts of a Computer

Unit Objectives
At the end of this unit, participants will be able to:
• Identify the basic parts of a computer
• Identify the basic parts of a keyboard
• Recall basic computer terminology
• Recall the functions of basic computer keys

Resources to be Used
• Participant Handbook
• Computer Systems with the required applications

Say
• Let’s take a quick recap of the basic computer parts.
• Discuss ‘Basic Parts of Computer’ and ‘Basic Parts of a Keyboard’ with the class as given in the Participant Handbook.

Explain
• Explain all the parts of the computer and the keyboard by demonstrating on the real system.

Ask
• Do you know about internet?
• Have you ever used internet?
• Why do you think internet is useful?
• What was the last task you performed on internet?

Say
• Let’s look at some basic internet terms.
• Discuss ‘Basic Internet Terms’ with the participants as given in the Participant Handbook.

Summarize
• Ask the participants what they have learnt from this exercise/activity.
• Ask if they have any questions related to what they have talked about so far.
• Close the discussion by summarizing the importance of computer and internet for entrepreneurs.
Do

- Group the participants for the activity depending on the batch size and the number of computer systems available in the lab.
- Explain the purpose and duration of the activity.
- Ensure the participants complete the practical exercises assigned.

Practical

- Conduct a practical session.
- Ask the participants to assemble in the computer lab.
- Give some hands on practice exercises.
UNIT 10.2.2: MS Office and Email: About MS Office

Unit Objectives
At the end of this unit, participants will be able to:
• Discuss the main applications of MS Office
• Discuss the benefits of Microsoft Outlook

Resources to be Used
• Participant Handbook
• Computer Systems with MS Office

Ask
• What is the most frequent activity that you do on the computer?
• Do you know how to make presentations on the computer?

Say
• Give a brief introduction of MS Office as given in the Participant Handbook.
• Discuss the most popular office products. Explain in brief their application, benefits and working.
• Microsoft Word is a word processing program that allows for the creation of documents. The program is equipped with templates for quick formatting. There are also features that allow you to add graphics, tables, etc.
• Microsoft Excel is a tool for accounting and managing large sets of data. It can also simplify analysing data. It is also used to create charts based from data, and perform complex calculations. A Cell is an individual data box which will have a corresponding Column and Row heading. This gives the cell a name, referred to as the Cell Reference. There can be multiple pages in each workbook. Each page, or sheet, is called a Worksheet. When you open a new Excel file, it automatically starts you with three worksheets, but you can add more.

Explain
• Explain the working and frequently used features of Office on a real system.

Ask
• What do you know about e-mails?
• Do you have an email id?
• How often do you check your e-mails?

Say
• Communication is vital for every business. The fastest and the safest way to communicate these days are through emails. MS Outlook helps to manage your emails in a better way and also offers a host of other benefits.
• Discuss "Why Choose Microsoft Outlook?" with the participants as given in the Participant Handbook.
Do

- Ask the participants to assemble in the computer lab.
- Explain the working of Outlook on a real system.

Demonstrate

- Demonstrate how to create email id.
- Demonstrate how to write new mails, send mails.
- Demonstrate how to use MS Office application to create a letter and send it as attachment in an email.
- Demonstrate how to use other MS Office applications.

Practical

- Give some hands on practice exercises
- Group the participants for the activity depending on the batch size and the number of computer systems available in the lab.
- Explain the purpose and duration of the activity.

Summarize

- Ask the participants what they have learnt from this exercise/activity.
- Ask if they have any questions related to what they have talked about so far.
UNIT 10.2.3: E-Commerce

Unit Objectives
At the end of this unit, participants will be able to:
• Identify different types of e-commerce
• List the benefits of e-commerce for retailers and customers
• Discuss Digital India campaign will help boost e-commerce in India
• Describe how you will sell a product or service on an e-commerce platform

Resources to be Used
• Computer System with internet connection
• Participant Handbook

Ask
• How many of you have done shopping online?
• Can you name at least five shopping websites?
• What is the product that you most frequently buy online?
• Why do you do shopping online instead of going to the market?

Say
• Give a brief introduction of “What is E-commerce”. Refer to the Participant Handbook.
• E-commerce emerged in the early 1990s, and its use has increased at a rapid rate. Today, many companies sell their products online. Everything from food, clothes, entertainment, furniture and many other items can be purchased online.

Ask
• What other types of transactions have you performed on the internet other than buying products?

Say
• Give examples of e-commerce activities from Participant Handbook.

Team Activity
E-commerce examples
• Instruct the participants to list some of the payment gateways that they have used for e-commerce activities.
• Give them 5 minutes to make this list.
• Discuss payment gateways and transaction through payment gateways.
• Conclude the discussion by mentioning how important e-commerce has become in our day to day transactions.
E-commerce activities can be classified based on the types of participants in the transaction. Discuss “Types of E-commerce” from the Participant Handbook.

Discuss all types of E-commerce by giving examples and names of some popular websites which use them. Make the discussion interactive by asking the class to share some popular e-commerce sites of each type.

E-commerce activities bring a host of benefits for both, retailers and customers. Discuss benefits of E-commerce from the Participant Handbook.

The majority of the population that uses E-commerce activities lives in tier-1 and tier-2 cities. To encourage the use of digital money in tier-3 and 4 areas, PM Mr. Modi launched the “Digital India Campaign”. Discuss “Digital India Campaign” from the Participant Handbook.

By Digital India project the government will deliver services via mobile connectivity and in doing so, is expected to bring the internet and broadband to remote corners of the country. This connectivity will in turn enhance e-commerce activities also. Furthermore, the Indian Government is also modernizing India Post and aims to develop it as a distribution channel for e-commerce related services.

Now let us discuss how to sell a product using E-commerce.

Every product has to be sold on a platform on the internet. Think of it as a shop that you have to sell your product. Now this shop can be your own or shared or rented. If the shop is your own or rented there will be only your products in that shop. If the shop is shared, there will be products of multiple sellers in that shop. A common example is a departmental store which has products from multiple brands in the shop.

Similarly, in E-commerce the shop is the website where your products are displayed. If it is your own website it will exclusively showcase your products. In this case the cost that you will incur will be:

- Developing the website
- Hosting the website
- Maintenance of the website

If you rent a website it will also showcase your own products but the development, hosting and maintenance parts goes to the owner. This saves time and the cost to manage these activities.

Smaller companies usually go for renting a website and the bigger ones develop their own website.

The concept of shared platforms has become very popular in recent times. In this platform the sellers have to register and then they can sell their goods on a common platform. Among the most popular of these are Amazon, Myntra, Flipkart, etc.

Tell the participants to choose a product or service that they want to sell online.

Tell them to write a brief note explaining how they will use existing e-commerce platforms, or create a new e-commerce platform to sell their product or service.
Demonetization has made carrying cash in the wallet very difficult. People either shop through cards or some other form of digital money. So what do you think is digital money? In this form the money is both paid and received digitally. There is no hard cash involved. It is an instant and convenient way to make payments. There are various types of digital payments. Let us discuss some of them in brief here. The first one is the most commonly used system i.e. the cards. Debit card, credit card, prepaid card, all fall under this category. Then is the e-wallet or the mobile wallet. This has become the most used form of digital money after demonetization. Examples are Paytm, state bank buddy, Freecharge, etc. Many other forms of digital money are also coming up in market like mobile apps, Aadhar card based payment, etc.

Digital money gives a lot of advantages over the conventional hard cash. Some of them are:
- Digital payments are easy and convenient. You do not need to take loads of cash with you, a mobile phone or a card will suffice.
- With digital payment modes, you can pay from anywhere anytime.
- Digital payments have less risk.

Ask
- How much money are you carrying in your wallet?
- Do you have a credit/debit card?
- How do you make payments while doing online shopping?

Do
- Demonstrate how to make and receive payments through digital models like Paytm and state bank buddy.

Ask
- Why do you think people have started using digital money instead of hard cash? Is demonetization the only reason?

Say
- Digital money gives a lot of advantages over the conventional hard cash. Some of them are:
  - Digital payments are easy and convenient. You do not need to take loads of cash with you, a mobile phone or a card will suffice.
  - With digital payment modes, you can pay from anywhere anytime.
  - Digital payments have less risk.

Summarize
- Ask the participants what they have learnt from this exercise/activity.
- Ask if they have any questions related to what they have talked about so far.
- Close the discussion by summarizing the importance of e-commerce and digital money.
UNIT 10.3: Money Matters

Key Learning Outcomes

At the end of this unit, participants will be able to:
1. Discuss the importance of saving money
2. Discuss the benefits of saving money
3. Discuss the main types of bank accounts
4. Describe the process of opening a bank account
5. Differentiate between fixed and variable costs
6. Describe the main types of investment options
7. Describe the different types of insurance products
8. Describe the different types of taxes
9. Discuss the uses of online banking
10. Discuss the main types of electronic funds transfer
UNIT 10.3.1: Personal Finance – Why to Save?

Unit Objectives
At the end of this unit, participants will be able to:
- Discuss the importance of saving money
- Discuss the benefits of saving money

Resources to be Used
- Participant Handbook

Ask
- How many of you save money?
- Why do you feel the need to save it?
- Do you plan your savings?
- Where do you keep the money you save?
- How do you use the money that you have saved?

Example
- Let’s look at these two examples:

Example 1:
Suhani works in a good company and earns Rs.30,000 month. She always saves 5000 per month and keeps it aside as a personal saving. She keeps the money at home and has saved quite a lot. One day her mother has a medical emergency and has to be taken to the hospital. Her family is worried about the amount they have to spend for the treatment. It will cost them at least 40,000.
Suhani says tells her family not to worry and that she has about 50,000, which she has saved over the months.

Example 2:
Jasmeet works in the same company and earns the same as Suhani. She is very fond of shopping and spends most of her money on buying new clothes. At the end of the month, she is always asking her father for money as her pay is finished.

Ask
- Who do you identify with—Suhani or Jasmeet?
- How do you think Suhani manages to save money which Jasmeet is unable to do?

Say
- We should always set aside some and save some money from our monthly pay. The future is unpredictable. Saving money not only gives you a sense of financial security but it can be used in case of emergencies.
- Discuss “Importance of Saving” with the participants as given in the Participant Handbook.

Ask
- What are the benefits of saving money?
- What does being financially independent mean to you?
Discuss “Benefits of Saving” with the participants as given in the Participant Handbook.

Now let us continue with Suhani’s story. Suhani has told her family not to worry and that she has about 50,000, which she has saved over the months. The family is happy about Suhani’s decision of saving money, which will be of great help for them now.

Suhani is going to the hospital today to pay the first instalment for the treatment. Suddenly finds only 35,000 in her cash box when she counts and does not remember using it. She has not kept any record and now she is upset.

Was it a good decision by Suhani to save a part of her earnings every month?

Was it a wise decision to keep all her savings as cash in a cash box?

Could she have managed to save money in a better and more effective manner?

Do you want to learn how to save money and use it effectively?

Let’s learn personal saving with the help of a group activity.

This activity has two parts:

**PART 1**
WAYS TO SAVE MONEY

- You are earning 30,000/- per month. You have recently changed your job and have to move to a metropolitan city. You are now living as a paying guest paying 10,000/- per month. Your other estimated expenditures like travel, food, recreation would be around Rs. 17,000 per month.
- Make a list of different ways to save money.

**PART 2**
HOW WILL YOU USE THE MONEY

- After a year how much have you been able to save?
- How will you use the money that you have saved?

Divide the class into groups of four.
Instruct the participants to think and prepare a list of the various ways they can save money.
Give the participants 10 minutes to prepare the list.
Once done, instruct them to think of how they could use the money they have saved.
Give the participants 10 minutes to prepare the list.
Keep a check on time. Tell the group to wind up quickly if they go beyond the given time limit.

What were the different ways you could save money?
How much money were you able to save?
How will you use the money you have saved in one year?
Say

- Discuss the importance of personal finance and why it is important to save money.

Summarize

You can summarize the session by discussing:

- The importance of saving money.
- Ways to save money.
- How the money saved can be used for different purposes.
UNIT 10.3.2: Types of Bank Accounts, Opening a Bank Account

Unit Objectives
At the end of this unit, participants will be able to:
- Discuss the main types of bank accounts
- Describe the process of opening a bank account

Resources to be Used
- Account opening sample forms
- Participant Handbook

Ask
- How many of you save money?
- Where do you keep the money you save?
- How many of you have a bank account?
- What type of account do you have?

Example
- Let's look at the given example:

Reena is in the third year of college but in the evening she gives tuitions for children living in her colony. She earns 15,000/- per month. As her students stay in different parts of the city, she has to walk a lot.

To save time, she decides to buy a second hand scooter for herself. But she has to save money for it. Her classmate advises her to open a recurring deposit account in the bank.

She goes to the bank close to her home. The personal manager gives her some forms to fill. She is confused as she has never done this before. Her elder sister has an account in the same bank. She asks for help from her sister. She goes to the bank the next day with her sister. The personal banker gives her a list of documents that she will need to submit with the form for opening an account. The banker advises her to open a 6 months recurring deposit.

Ask
- Do you try to save money monthly but have to spend it on unforeseen expenditure?
- Have you ever thought of depositing your savings in a bank?

Say
- Before opening a bank account, you need to know the types of accounts we have in India.
- Discuss “Types of Bank Accounts” with the participants as given in the Participant Handbook.

Ask
- Can someone say what are the different types of bank accounts?
Facilitator Guide

Say

• Let's learn about the different types of bank accounts through an activity.

Team Activity

• Divide the class in four groups.
• Label the groups as savings account, current account, recurring account and fixed deposit.
• On a chart paper, ask them to write the key points of their account.

Activity De-brief

• Ask each group to present the key points of their account.

Say

• Now that you know about the four different types of accounts, let's learn how to open a bank account.
• Discuss “Opening a Bank Account” with the participants as given in the Participant Handbook.
• Discuss “Tips” that the participants should keep in mind while opening a bank account as given in the Participant Handbook.

Ask

• What are the main documents required for opening a bank account?
• What are some important points to ask the bank personnel while opening an account?

Say

• Mention officially valid KYC documents (refer to the Participant Handbook)
• Now, let's understand the procedure of opening a bank account through an activity.

Team Activity

Opening a Bank Account

• This activity is done in groups.
• Divide the class in groups of four or six.

PART 1

FILLING A BANK ACCOUNT OPENING FORM

• You have to fill a bank opening form.
• You can refer to the section “Opening a Bank Account” of your Handbook for reference.
• List all the steps that you will be required to fill in the form.
• List the documents that you need for filling the form.
• Now fill in the form.

Activity De-brief

How did you design the form?

• What all details did you fill in the form?
• What were your KYC documents?
• How would this activity help you in future?
Do

- Instruct the participants to read the section “Opening a Bank Account’ of the Participant Handbook.
- Give each group one sample account opening form.
- Give the participants 5 minutes to read the form.
- Give them 15 minutes to fill it.
- Assist them by explaining each category and how to fill it.
- Keep a check on time.
- Tell the group to wind up quickly if they go beyond the given time limit.

Summarize

Note:
- You can summarize the unit through a role play.
  - A person wanting to open an account in the bank.
  - What is the procedure that he will go through?
  - Discuss the key points of different types of bank accounts.
  - How to select the type of account
  - How to fill the account opening form.
- A sample account opening form is given in the following page for reference. Use it for the activity in the class.

Sample Bank Account Opening form.

XXX Bank

SAVING BANK ACCOUNT OPENING FORM

Account No.: __________________________ Date: ______________________

Name of the Branch
Village/Town
Sub District / Block Name
District
State
SSA Code / Ward No.
Village Code / Town Code Name of Village / Town

Applicant Details:
Full Name | Mr./Mrs./Ms. | First | Middle | Last Name
Marital Status
Name of Spouse/Father
Name of Mother
Address
Pin Code
Tel No. Mobile Date of Birth
Aadhaar No. | Pan No.
MNREGA Job Card No.
Occupation/Profession
Annual Income
No. of Dependents
### Detail of Assets

<table>
<thead>
<tr>
<th></th>
<th>Y/N</th>
<th>Y/N</th>
<th>Any other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owning House</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owning Farm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of Animals</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Existing Bank

<table>
<thead>
<tr>
<th>A/c. of family members / household</th>
<th>Y / N</th>
<th>If yes, No. of A/cs.</th>
</tr>
</thead>
</table>

### Kisan Credit Card

<table>
<thead>
<tr>
<th>Whether Eligible</th>
<th>Y / N</th>
</tr>
</thead>
</table>

I request you to issue me a Rupay Card.

I also understand that I am eligible for an Overdraft after satisfactory operation of my account after 6 months of opening my account for meeting my emergency/ family needs subject to the condition that only one member from the household will be eligible for overdraft facility. I shall abide by the terms and conditions stipulated by the Bank in this regard.

---

### Declaration:

I hereby apply for opening of a Bank Account. I declare that the information provided by me in this application form is true and correct. The terms and conditions applicable have been read over and explained to me and have understood the same. I shall abide by all the terms and conditions as may be in force from time to time. I declare that I have not availed any Overdraft or Credit facility from any other bank.

**Place:**

**Date:**

**Signature / LTI of Applicant**

### Nomination:

<table>
<thead>
<tr>
<th>I want to nominate as under</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of Nominee</td>
</tr>
<tr>
<td>------------------</td>
</tr>
</tbody>
</table>

**Place:**

**Date:**

**Signature / LTI of Applicant**

**Witness(es)**

1. _______________________
2. _______________________

*Witness is requires only for thumb impression and not for signature*
UNIT 10.3.3: Costs: Fixed vs. Variables: What are Fixed and Variable Costs?

Unit Objectives
At the end of this unit, participants will be able to:
• Differentiate between fixed and variable costs

Resources to be Used
• Participant Handbook
• Blank sheets of paper
• Pens

Ask
• What is cost?
• Will a telephone bill fall under the category of a fixed or variable cost?

Say
• Discuss: Fixed and Variable cost with examples. Let us do a small activity.

Team Activity
Identify the type of cost
1. Rent
2. Telephone bill
3. Electricity bill
4. Machinery
5. Insurance
6. Office supplies/ Raw materials
7. Employee salaries
8. Commission percentage given to sales person for every unit sold
9. Credit card fees
10. Vendor bills

Do
• Divide the class into two groups. Read out the list of costs given in the activity.
• Read out each item from the cost list and ask the groups in turns to identify whether it is a fixed or variable cost.
Say

- We saw that your utility bills like rent, electricity, telephone etc. are all fixed costs because you have to pay it every month.
- Variable costs is an expense which varies with production output or volume. For example commission, raw material etc.
- Discuss “Cost: Fixed vs. variables” with the participants as given in the Participant Handbook.
- Illustrate the relation between the costs with a graph.

```
Fixed vs. Variable Costs
```

![](image)

- Let’s learn the difference between fixed and variable cost with the help of an activity.

Team Activity

**Fixed vs. Variable Costs**

- This is a group activity.

  - You want to start your own entrepreneur business.
  - State the type of business you want to start.
  - List down all the cost or requirements for your business.
  - How will you differentiate between the fixed and variable cost.

**Activity De-brief**

- What is the total cost of your business?
- What are the fixed costs?
- What are the variable costs?
- How did you differentiate between the fixed and variable costs?

Do

- Instruct the participants that this is group work.
- Divide the class into small groups of 4 or 6.
- Give each group a sheet of paper.
- Tell the participants that they have to start their own entrepreneur business.
- Ask them the type of business they want to start.
- Instruct them to differentiate between the fixed and the variable costs of the business they want to start.
- Give the participants 15 minutes to discuss and write.
- Keep a check on time. Tell the group to wind up quickly if they go beyond the given time limit.
Summarize

* Note: You can summarize the unit either by having a role play between a consultant and a budding entrepreneur explaining the differences between fixed and variable costs or by discussing the key points of the unit.

Notes for Facilitation

* Answers for the activity - Identify the type of cost

1. Rent (Fixed)
2. Telephone bill (Fixed)
3. Electricity bill (Fixed)
4. Machinery (Fixed)
5. Insurance (Fixed)
6. Office supplies/ Raw materials (Variable)
7. Employee salaries (Fixed)
8. Commission percentage given to sales person for every unit sold (Variable)
9. Credit card fees (Variable)
10. Vendor bills (Variable)
UNIT 10.3.4: Investments, Insurance and Taxes

Unit Objectives
At the end of this unit, participants will be able to:
- Describe the main types of investment options
- Describe the different types of insurance products
- Describe the different types of taxes

Resources to be Used
- Participant Handbook

Ask
- Ask the participants- “What do you see first thing in when you get your mobile bill? Apart from the amount and due date do you have a look at the taxes you are being billed for?”
- Why do you think people get their cars insured or have a medical insurance?
- You have saved money and want to invest it, how would you decide what is the best investment for your money?

Example
- Let’s have a look at a few scenarios.
  - Ranbir has sold his house and deposited the money in his bank. His Chartered Accountant tells him that he will have to re-invest the money otherwise he will have to pay capital tax. What is capital tax and how is it different from income tax?
  - Jasmeet and Anup are blessed with a baby girl. They decide to have an insurance policy that will mature when their daughter is ready to higher education.
  - Shivani is working in a corporate office and getting good pay. She will have to pay income tax so she decides to invest her money in tax saving schemes. She goes to the bank manager to discuss the best products in which she can invest.

Say
- Discuss the Investment, Insurance and Taxes as given in the Participant Handbook.

Ask
- How do investments, insurances and taxes differ from each other?

Say
- Let’s learn the differences between the three by having an activity.

Say
- We will have a quiz today.
Team Activity

• The activity is a quiz.

Do

• Divide the class into groups of three and give a name to each group
• Explain the rules of the quiz. For each correct answer the group gets 1 mark. If the group is unable to answer the question is rolled over to the next group.
• Explain the purpose and duration of the activity.
• On the blackboard write the names of the groups.
• Ask the questions of the quiz.
• Keep a score for the groups.
• Set guidelines pertaining to discipline and expected tasks.

Summarize

• Summarize the unit by discussing the key points and answering question

Notes for Facilitation

Questions for the quiz

1. What are bonds?
   Bonds are instruments used by public and private companies to raise large sums of money.
2. Who issues the bonds?
   Private and public companies issue the bonds.
3. Why are bonds issued?
   To raise large amount of money as it cannot be burrowed from the bank.
4. Who is the buyer of stocks and equities?
   The general public is the buyer.
5. What types of scheme is the Sukanya Samriddhi Scheme?
   Small Saving Scheme
6. What is the difference between mutual and hedge funds?
   Mutual funds are professionally managed financial instruments that invest the money in different securities on behalf of investors. Hedge funds invest in both financial derivatives and/or publicly traded securities.
7. Why is a loan taken from the bank to purchase real estate?
   To lease or sell to make profit on appreciated property price.
8. Name the two types of insurances?
   Life Insurance and Non-life or general insurance
9. Which insurance product offers financial protection for 15-20 years?
   Term Insurance
10. What is the benefit of taking an endowment policy?
    It offers the dual benefit of investment and insurance.
11. Mr. Das gets monthly return on one of his insurance policies. Name the policy?
    Money Back Life Insurance
<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>12. What are the two benefits of a Whole Life Insurance?</td>
<td><em>It offers the dual benefit of investment and insurance</em></td>
</tr>
<tr>
<td>13. Which policy covers loss or damage of goods during transit?</td>
<td><em>Marine Insurance</em></td>
</tr>
<tr>
<td>14. After what duration is the income tax levied?</td>
<td><em>One financial year</em></td>
</tr>
<tr>
<td>15. What is long term capital gain tax?</td>
<td><em>It is the tax payable for investments held for more than 36 months.</em></td>
</tr>
<tr>
<td>16. Name the tax that is added while buying shares?</td>
<td><em>Securities Transaction Tax</em></td>
</tr>
<tr>
<td>17. What is the source of corporate tax?</td>
<td><em>The revenue earned by a company.</em></td>
</tr>
<tr>
<td>18. Name the tax whose amount is decided by the state?</td>
<td><em>VAT or Value Added Tax</em></td>
</tr>
<tr>
<td>19. You have bought a T.V. What tax will you pay?</td>
<td><em>Sales Tax</em></td>
</tr>
<tr>
<td>20. What is the difference between custom duty and OCTROI?</td>
<td><em>Custom duty is the charges payable when importing or purchasing goods from another country. OCTROI is levied on goods that cross borders within India.</em></td>
</tr>
</tbody>
</table>
UNIT 10.3.5: Online Banking, NEFT, RTGS, etc.

Unit Objectives
At the end of this unit, participants will be able to:
• Discuss the uses of online banking
• Discuss the main types of electronic funds transfer

Resources to be Used
• Participant Handbook
• Computer System with internet connection
• Debit card

Ask
• When was the last time you visited a bank?
• How do you pay your bill for electricity and telephone?
• Have you ever tried to transfer money from one bank account to another bank account using the online banking facility?

Say
• Most of us lead a busy life. Time has become more important than money. In this busy schedule no one has time to stand in bank queues. That’s where Online Banking comes in. Online banking or internet banking means accessing your bank account and carrying out financial transactions through the internet.
• Discuss “What is online banking?” from the Participant Handbook.
• There are various advantages of online banking:
  • It saves time, as you need to visit the branch.
  • You can conduct your banking transactions safely and securely without leaving the comfort of your home.
  • Online Banking also gives you round the clock access.
  • Online Banking makes it possible for you to pay your bills electronically.

Do
• Show them how they can use the internet banking.
• Use the computer system and show the demo videos on how to use internet banking provided on most banking sites. the computer system.
• Tell the class the various features of online banking:
  • Through their website set-up your online account.
  • Choose a secure username and password.
  • Set-up your contact information.
  • Once your information is verified, you are good to go.
  • Once you enter the portal explore all the features and learn your way through the portal.
• Discuss about maintaining the security of the online account.
Say

- One of the biggest advantages that online banking offers, as discussed earlier, is transferring money from one account to another. This transaction is called electronic funds transfer. Electronic transfers are processed immediately with the transferred amount being deducted from one account and credited to the other in real time, thus saving time and effort involved in physically transferring a sum of money.
- Discuss “Electronic Funds Transfer” from the Participant Handbook.

Do

- Discuss how to transfer money from one account to another using online banking (NEFT/ RTGS, etc.).
- Illustrate with an example.

Summarize

- Close the discussion by summarizing the about online banking.
- Ask the participants if they have any questions related to what they have talked about so far.
At the end of this unit, participants will be able to:
1. Discuss the steps to follow to prepare for an interview
2. Discuss the steps to create an effective Resume
3. Discuss the most frequently asked interview questions
4. Discuss how to answer the most frequently asked interview questions
5. Identify basic workplace terminology
UNIT 10.4.1: Interview Preparation: How to Prepare for an Interview?

Unit Objectives
At the end of this unit, participants will be able to:
• Discuss the steps to follow to prepare for an interview

Resources to be Used
• Participant Handbook

Ask
• Have you ever attended an interview?
• How did you prepare before going for an interview?

Say
• An interview is a conversation between two or more people (the interviewer(s) and interviewee) where questions are asked by the interviewer to obtain information from the interviewee.
• It provides the employer with an opportunity to gather sufficient information about a candidate and help them select the ideal candidate.
• It also provides the interviewee with an opportunity to present their true potential to the employer, build confidence and help make a decision about the job by asking questions regarding designation, salary, perks, benefits, promotions, transfers, etc.
• Let’s do an activity to understand how to prepare for interviews better.

Activity 1
• Introducing Yourself

Do
• Select a participant and ask him/her to answer the following questions: “What can you tell me about yourself?”
• Give the participant at least one minute to speak.
• Once he/she is done, ask the rest of the participant what they gathered about the participant who was providing information.
• Now repeat the exercise with five other participants.

Ask
• What information you should include when you are describing or introducing yourself in an interview?
• What information you should not include when you are describing or introducing yourself in an interview?
**Say**

- Tell the participants that when an interviewer asks you to say something about yourself, he/she is not asking you to present your life history.
- Introduction should be short and crisp, and should present you in a positive light. It should include the following points:
  - Any work experience that you might have
  - A brief summary of your educational qualifications
  - Your strengths and achievements
  - Any special projects that you might have been part of
- The following topics should be avoided during an introduction:
  - Detailed description of your family (unless you are specifically asked to do so)
  - Too much information about your weaknesses
  - Information that is not true

**Do**

- Congratulate each participant for sharing their points.
- Ask the audience to applaud for them.
- Ask de-brief questions to cull out the information from each group.
- Keep a check on time.

**Activity 2**

- Planning the right attire

**Do**

- Describe 2 individuals to the participants. One is wearing a casual t-shirt, jeans, and slippers. He has not combed his hair and neither has he trimmed or shaved his beard. The other individual is dressed formally with a shirt and pant, and is well-groomed. He has also worn formal shoes and a belt. Ask the participants which person would they prefer to hire in their organization and why?

**Summarize**

- Close the discussion by discussing 'how to prepare for an interview' as discussed in the Participant Handbook.
- You can add the following points to it:
  - Tell the participants to create a positive and good impression in an interview. It is important for them to prepare for an interview beforehand.
  - The interviewer analyses not only your technical knowledge in relation to the job, but also whether or not you are a fit for the organization.
  - Every employer looks at the whole package and not just one or two things in isolation. Therefore, the way you dress and the way you present yourself is also important along with your skills and talents.
  - The participants will get only one chance to create a good first impression.
UNIT 10.4.2: Preparing an Effective Resume: 
How to Create an Effective Resume?

Unit Objectives
At the end of this unit, participants will be able to:
• Discuss the steps to create an effective Resume

Resources to be Used
• Participant Handbook
• Blank papers
• Pens

Ask
• When preparing for an interview, what are the most important things that you need to do?
• What documents do you carry with you, when you go for an interview?
• What is a resume?
• Why do you need a resume?

Say
• Resume is not just a sheet of paper with your qualifications printed on it.
• It is a selling tool that will help the employer to see how and what you can contribute for company.
• Talk about the steps involved in creating an effective/attractive resumes discussed in the Participant Handbook.
• Now let’s prepare a resume to understand the process in a better way.

Do
• This is an individual activity.
• Give the details of the activity.
• Instruct them to read the activity carefully.
• The participant is expected to make an attractive resume based on the information provided.
• Give the class 25-30 minutes to study the case and create a resume.
• At the end of 30 minutes, the participants should exchange the resume with the person sitting next to him or her.
• Every participant will evaluate the resume prepared with their fellow participants.

Say
• Do you think the candidate should apply for the job posting described in the advertisement?
• We have already discussed the steps involved in creating an effective/attractive resumes.
• Now let’s prepare a resume for the candidate details given in the activity.
Activity

Case Study Analysis

- In the first section of the activity, you are being given the information about a candidate who is applying for a particular job.
- In the second section, you are being given the detailed description of the job posting. Create a resume for the candidate to apply for the job posting.
- Use the information that has been provided about the candidate to create this resume.

Candidate Details

Nipesh Singla was born on 20th April, 1988 in Chandigarh, India. He currently resides at 1XX7, Sector XX D, Chandigarh –160018. His mobile number is 988XXXXX01, and e-mail address is nxxxxxxxxxla@gmail.com. Nipesh attended middle and senior school at Government Boys Senior Secondary School, Sector 15, Chandigarh. He has been a very talented boy since school. He was fond of painting and watching old Hindi movies. As part of a school charity program, he volunteered at the children's hospital during his senior years.

In July 2007, he joined Westwood School of Hotel Management, Zirakpur to pursue a diploma course in Hotel Management and Catering. After completing this course, he joined XYZ Group of Hotels as a Housekeeping intern in June 2010 for six months. In this role, he was responsible for cleanliness and maintenance of one floor in the hotel. Taking advantage of his strong interpersonal skills, he also got opportunities to make housekeeping arrangements for corporate meetings. While pursuing education, he gained working knowledge of Microsoft Word, Excel, Access and PowerPoint.

Nipesh is detail-oriented, flexible and adaptable. He has successfully worked with a diverse work force. He gelled well with his peers, both in college and during his internship. After completing the internship, his objective has been to find a job opportunity where he can use his skills and experience. Backed by experience, he is confident about his skills as housekeeping assistant.

Job Posting

* Do you see yourself as a HOUSEKEEPING SUPERVISOR?

What's your passion? Whether you’re into cricket, reading or hiking, at IHG we are interested in YOU. At IHG, we employ people who apply the same amount of care and passion to their jobs as they do in their hobbies - people who put our guests at the heart of everything they do. And we’re looking for more people like this to join our friendly and professional team.

THE LOCATION:

At the moment, we are looking for HOUSEKEEPING SUPERVISOR to join our youthful and dynamic team at Holiday Inn Amritsar, Ranjit Avenue in Amritsar, Punjab (India). Holiday Inn Amritsar is ideally located in Amritsar’s commercial district on Ranjit Avenue with the world famous Golden Temple located only a short distance away. Sparkling chandeliers mark an incomparable arrival experience as you escape to the welcoming environment that is, Holiday Inn Amritsar. The fresh international brand to celebrate and explore Amritsar.

*Salary: Negotiable
*Industry: Travel / Hotels / Restaurants / Airlines / Railways
*Functional Area: Hotels, Restaurants
*Role Category: Housekeeping
*Role: Housekeeping Executive/Assistant.

Desired Candidate Profile

Friendly, pleasant personality, Service - oriented.

You should ideally be Graduate/ Diploma holder in HM and at least 2 years of experience as a supervisor in good brand with good communication skills, English is a must.
In return we'll give you a competitive financial and benefits package. Hotel discounts worldwide are available as well as access to wide variety of discount schemes and the chance to work with a great team of people. Most importantly, we'll give you the room to be yourself.

*Please get in touch and tell us how you could bring your individual skills to IHG.

Education-

*UG: Any Graduate/ Diploma holder

*PG: Post Graduation Not Required

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**Facilitator Guide**

**Say**

- Now, let's share the resume with the fellow participant sitting next to you and evaluate each other's effort.

**Do**

- Congratulate each participant for making their first attempt towards creating an effective resume.
- As a follow up activity, you can suggest them to prepare their own resume and show it to you the next day.

**Summarize**

- Close the discussion by showing some effective resume samples to the candidates.
- Ask the participants what they have learnt from this activity.
- Ask if they have any questions related to what they have talked about so far.

**Notes for Facilitation**

- Keep printed copies of the activity ready for the session.
- Put down the suggested format of the resume on the board while explaining the steps in preparing a resume.
- Do check the participants' resume and suggest necessary changes.
- Suggested example for the case presented:

Nipesh Singla
#1XX7, Sector XX-D
Chandigarh-160018
Mobile No: 91-988XXXXX01
E-mail: nxxxxxxxxxla@gmail.com

**Objective:** Seeking an opportunity to use my interpersonal skills and experience to contribute to your company's growth, profitability and objectives.

**Professional strengths:**
- Proficient in housekeeping
- Experienced in and capable of working with a diverse work force
- Team player and friendly in nature
- Successful working in a multi-cultural environment
• Detail oriented, flexible, and adaptable
• Knowledge of Microsoft Word, Excel, Access and PowerPoint

**Educational background:**
• Diploma in Hotel Management and Catering, Westwood School of Hotel Management, Zirakpur
• High School, Government Boys Senior Secondary School, Sector 15, Chandigarh

**Professional internships:**
• Housekeeping Intern, XYZ Group of Hotels, New Delhi (June 2010 – August 2010)
  • Responsible for cleanliness and maintenance of one floor in the hotel.
  • Got opportunities to make housekeeping arrangements for corporate meetings.

**Volunteer Work:**
• Student volunteer at children’s hospital in Chandigarh.

Nipesh Singla
UNIT 10.4.3: Interview FAQs

Unit Objectives

At the end of this unit, participants will be able to:

• Discuss the most frequently asked interview questions
• Discuss how to answer the most frequently asked interview questions

Resources to be Used

• Participant Handbook

Say

• Tell the participants you will provide them with interview situation and questions and they have to try to answer them.
• Tell them you will also explain the different ways to approach these questions.

Do

• Divide the class in pairs and ask the participants to perform a role play.
• One partner will play the role of the interviewer while the other will play the role of the interviewee.
• Tell them the interviewer can start the interview by asking the interviewee to introduce himself/herself.
• Call all the pairs one by one in front of the class to enact the role play.
• Follow the same pattern for all other situations.
• Time allotted for each situation is 8-10 minutes.
• Congratulate each participant for giving their input.
• Ask the class to applaud each time a team has completed their role play.
• Keep a check on time.

Role Play

Conduct a role play for the situation given.

Situation 1

• The interviewer will start by asking the interviewee a few generic questions such as:
  • What is your name?
  • Tell me something about yourself?
  • Can you tell me something about your family?
• Then, the interviewer will bluntly ask the following questions:
  • How do you explain this huge time gap in your resume?
  • What is the reason for this?
  • Weren’t you looking for a job or is it that no one selected you?
**Say**

**De-brief:**
- When you put information on your resume, you should be prepared to answer any questions about it.
- Be present and focused on the questions being asked to you.
- One way of tackling the blunt questions is to tell the interviewer you did not come across an opportunity where you were sufficiently satisfied with both the remuneration offered as well as the profile. Therefore, you waited for the right opportunity to come along while looking for an ideal job.

**Role Play**

Conduct a role play for the situation given.

**Role Play – Situation 2**
- The interviewer will start by asking the interviewee a few generic questions such as:
  - What is your name?
  - Tell me something about yourself?
  - Can you tell me something about your family?
- Then, at the end of the interview, ask the interviewee:
  - There are over 200 people who have applied for this job, some with excellent work experience. Why should I hire you?

**Say**

**De-brief:**
- There is nothing wrong with stating your strengths and achievements. However, do not come across as arrogant or too boastful.
- You need show the interviewee that you have unique skills or talents to contribute to the company. The interviewer needs to know how you stand apart from the rest of the crowd.
- Tell the interviewer you are looking forward to working with the company and that you are a hard-working individual.

**Role Play**

Conduct a role play for the situation given.

**Role Play – Situation 3**
- The interviewer will start by asking the interviewee a few generic questions such as:
  - What is your name?
  - Tell me something about yourself?
  - Can you tell me something about your family?
- Then, lean forward, clasp your hands on the table and in a soft voice ask the interviewee:
  - Did you ever experience any neglect or disregard from your previous office? In other words, did you ever suffer because your office or team displayed favouritism?

**Say**

**De-brief:**
- Keep this in mind: Do not criticize anyone during an interview.
- You are free to express your opinion, however, your language, answers, body language, and the tone of your voice should remain constructive and neutral.
- Since criticism will show you in negative light, you should keep your answers honest yet diplomatic.
- You can tackle such questions by saying, “I got along well with most of my faculty and peers.”
Role Play

Conduct a role play for the situation given.

Role Play – Situation 4

- The interviewer will start by asking the interviewee a few generic questions such as:
  - What is your name?
  - Tell me something about yourself?
  - Can you tell me something about your family?
- Then very bluntly ask the interviewee:
  - How long do you plan to stay with this company if you are selected?
- After the candidate responds, ask sarcastically:
  - Do you seriously mean that?

Say

De-brief:

- Don’t provide unreal and idealistic answers.
- Your answers should be honest yet diplomatic. In a situation like this, the interviewer does not expect you to provide a specific timeline.
- You can say something like, “I would like to stay with the company as long as I can contribute constructively and develop as an employee, within the organization, professionally and financially.”

Role Play

Conduct a role play for the situation given.

Role Play – Situation 5

- The interviewer will start by asking the interviewee a few generic questions such as:
  - What is your name?
  - Tell me something about yourself?
  - Can you tell me something about your family?
- Ask him/her how important he/she thinks it is to be punctual in the corporate world.
- After he/she answers, look up sternly at the interviewee and in a crisp voice, say:
  - You were late for this interview by 10 minutes. That surely does not seem to be in line with what you just said?

Say

De-brief:

- Politely apologize for being late.
- You can add something such as, “I assure you this is not a habit”. All your future actions should be in line with this statement.
- Avoid giving any excuses.
- You might feel obligated to provide a justification for your tardiness, but the interviewer is not interested in that.
- Do not over apologize. Once this response is out of the way, turn your focus back to the interview.
Role Play

Conduct a role play for the situation given.

Role Play – Situation 6
- The interviewer will start by asking the interviewee a few generic questions such as:
  - What is your name?
  - Tell me something about yourself?
  - Can you tell me something about your family?
- After asking a few academic or job-related questions, ask the interviewee:
  - If you get this job, what salary package do you expect us to give you?

Say

De-brief:
- If there is no way for you to avoid this question, respond to the interviewer by providing a reasonable and well-thought-out salary range.

Role Play

Conduct a role play for the situation given.

Role Play – Situation 7
- The interviewer will start by asking the interviewee a few generic questions such as:
  - What is your name?
  - Tell me something about yourself?
  - Can you tell me something about your family?
- Then, bringing the interview to a close, ask the interviewee:
  - Do you have any questions for me?

Say

De-brief:
- Ask relevant questions.
- Don't bombard the interviewer with questions.
- If you have questions about the result of the interview, you can limit your questions to 1 or 2. Keep them short and relevant like:
  - When will I be informed about the results of the interview?
  - What are the working hours?
  - Will the job require me to travel?

Explain

- Tell the participants to be prepared for answering different types of questions in an interview.
- Stay calm and focused, and take a moment to think about how you should respond. Always maintain a confident tone.
- Even if you don't intend to, your body language conveys your level of discomfort with a particular question. Try to keep your actions, tone, and gestures neutral.
- Maintain your composure while answering personal questions.
**Do**

- Tell all the participants to form pairs again.
- Tell them to use the following list of frequently asked interview questions to conduct mock interviews.
- They will use all or some of these questions to conduct mock interviews with their partners.
- One partner will play the role of the interviewer while the other will play the role of the interviewee.
- After they are through asking and answering the questions, the roles will be reversed.
- The same list of questions will be used again.
- After each mock interview ask the interviewer to provide feedback and clear any doubts that may arise.
- Time allotted for each situation is 30-35 minutes.

**Activity**

**Mock Interview Questions**

<table>
<thead>
<tr>
<th>Mock Interview Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tell me something about your family.</td>
</tr>
<tr>
<td>What qualities would you look for in a Manager or a Supervisor?</td>
</tr>
<tr>
<td>Why did you apply for this job?</td>
</tr>
<tr>
<td>What do you know about this company?</td>
</tr>
<tr>
<td>How do you deal with criticism?</td>
</tr>
<tr>
<td>How do you plan to strike a good work-life balance?</td>
</tr>
<tr>
<td>Where do you see yourself five years from now?</td>
</tr>
<tr>
<td>Have you applied for jobs in other companies?</td>
</tr>
<tr>
<td>What kind of salary do you expect from this job?</td>
</tr>
<tr>
<td>Do you have any questions for me?</td>
</tr>
</tbody>
</table>

**Summarize**

- Close the discussion by discussing the questions in the both activities.
- Ask the participants what they have learned from this activity.
- Ask if they have any questions related to what they have talked about so far.
UNIT 10.4.4: Work Readiness – Terms and Terminology

Unit Objectives
At the end of this unit, participants will be able to:
• Identify basic workplace terminology

Resources to be Used
• Participant Handbook
• Chart papers
• Blank sheets of paper
• Pens

Ask
• What do you understand by workplace terminology?
• Are offer letter and contract of employment the same?

Say
• Let’s start this unit with an activity.

Team Activity
Workplace terminology
• This is a group activity conducted in three parts.

Part 1
Sheila received a call from the recruiter of MND Company. Before she is recruited by the company, think of the recruitment process she will have to go through. Start from the telephone call to signing her letter of acceptance. Write down all the words that come to your mind.

Activity De-brief
• Have the participants read out the words they have written
• Encourage all the participants to participate in the activity

Do
• Divide the class into small groups of 4 or 6.
• Instruct the participants that they will be doing a brainstorming activity.
• Give them one chart paper each. Tell them to divide the chart in two parts.
• Instruct them that they have to use one half of the chart paper now. The other half will be used later.
• The participants have to write all the words that come to their mind related to the recruitment process.
• Give them 10 minutes to do the activity.
• Tell them that there are no right or wrong answers.
• Keep a track of the time.
You all know quite a few words related to the terms used in the office. Let us talk about some new terms that have been missed out. Discuss “Work Readiness – Terms and Terminology” with the participants as given in the Participant Handbook.

- Why is it important to know the workplace terms?
- How do they help?
- Can the words be categorised further?

Let’s now continue the activity.

**Team Activity**

**Terms and Terminology**
- This is again a group activity. The members of the group remain the same as in Activity 1.

**Part 2**
With the help of the new terms you have learned, make a flow chart of the hiring process of MND Company.

**Activity De-brief**
- Ask the groups to share the flow charts and the new terms they added while preparing the flow chart.

Instruct the participants that they have to use the 2nd half of the same chart they had used before.
- Using the new terminology and the terms they had previously written on the chart, they have to make a flow chart of the hiring process of the MND Company.
- Give them 10 minutes for this activity.
- Keep a check on time. Tell the group to wind up quickly if they go beyond the given time limit.

Let’s go ahead with the activity.

**Team Activity**

**Terms and Terminology**
- The activity continues with the same group members.

**Part 3**
Sheila now works for the MND Company. She is not aware of the company culture and policies. She goes to the HR Department to get her doubts clarified. Can you think of the terms for which she wants clarity? Make a list of those words.

**Activity De-brief**
- Ask the groups to share their list of words. Some of the words are benefits, comp. time, deduction, employee training, holidays, lay-off, leave, maternity leave, mentor, notice, paternity leave, and time sheet.
Do

- Instruct the participants to identify the key terms an employee of a company should know. They can use the same chart paper for this activity.
- Give them 5 minutes for this activity.
- Keep a check on time. Tell the group to wind up quickly if they go beyond the given time limit.

Summarize

- Note: You can either summarize the key points of the unit or have a role play where an employee has just joined a company and the HR Manager explains the terms of employment.
Key Learning Outcomes

At the end of this unit, participants will be able to:
1. Discuss the concept of entrepreneurship
2. Discuss the importance of entrepreneurship
3. Describe the characteristics of an entrepreneur
4. Describe the different types of enterprises
5. List the qualities of an effective leader
6. Discuss the benefits of effective leadership
7. List the traits of an effective team
8. Discuss the importance of listening effectively
9. Discuss how to listen effectively
10. Discuss the importance of speaking effectively
11. Discuss how to speak effectively
12. Discuss how to solve problems
13. List important problem solving traits
14. Discuss ways to assess problem solving skills
15. Discuss the importance of negotiation
16. Discuss how to negotiate
17. Discuss how to identify new business opportunities
18. Discuss how to identify business opportunities within your business
19. Explain the meaning of entrepreneur
20. Describe the different types of entrepreneurs
21. List the characteristics of entrepreneurs
22. Recall entrepreneur success stories
23. Discuss the entrepreneurial process
24. Describe the entrepreneurship ecosystem
25. Discuss the purpose of the Make in India campaign
26. Discuss key schemes to promote entrepreneurs
27. Discuss the relationship between entrepreneurship and risk appetite
28. Discuss the relationship between entrepreneurship and resilience
29. Describe the characteristics of a resilient entrepreneur
30. Discuss how to deal with failure
UNIT 10.5.1: Concept Introduction (Characteristic of an Entrepreneur, types of firms/ types of enterprises)

Unit Objectives

At the end of this unit, participants will be able to:

- Discuss the concept of entrepreneurship
- Discuss the importance of entrepreneurship
- Discuss the characteristics of an entrepreneur
- Describe the different types of enterprises

Resources to be Used

- Participant Handbook

Say

- Let’s start this session with some interesting questions about Indian entrepreneurs.

Team Activity

Quiz Questions

1. Who is the founder of Reliance Industries?
   - Dhirubhai Ambani
2. Who is the Chairman of Wipro Limited?
   - Azim Premji
3. Who launched e-commerce website Flipkart?
   - Sachin Bansal and Binny Bansal
4. Who is the founder of Paytm?
   - Vijay Shekhar Sharma
5. Who is CEO of OLA Cabs?
   - Bhavish Aggarwal
6. Who is the founder of Jugnoo?
   - Samar Singla (autorickshaw aggregator)
7. Who is the founder of OYO Rooms?
   - Bhavish Aggarwal

Do

- Tell them that you will ask them few questions about a few entrepreneurs.
- Divide the class in to two groups.
- In turns ask the quiz questions to the groups.
- If the answer is incorrect pass the question to the other group.
- Share the answer if the groups are not able to answer.
- Congratulate the participants who answered correctly.
Ask

- What do you understand by entrepreneurs?
- What is the importance of entrepreneurship in today’s scenario?
- What do you think are the characteristics of successful entrepreneurs?
- What are different types of enterprises that an entrepreneur in India can own and run?

Say

- Talk about entrepreneurs, importance of entrepreneurship, characteristics of successful entrepreneurs, and different types of enterprises in India as discussed in the Participant Handbook.
- Tell the participants, stories of successful Indian entrepreneurs - their struggles, the moments of heartbreak, the perseverance and triumph.
- Ask them if they know of any such entrepreneur.

Summarize

- Close the discussion by summarizing about the opportunities for entrepreneurs in India.

Notes for Facilitation

- Check out different Government schemes for small entrepreneurs. Share the information with the participants.
- You can tell them about the government websites like Start Up India, mudra.org.in etc.
- Discuss about various schemes and policies by the Government of India for entrepreneurs.
UNIT 10.5.2: Leadership and Teamwork

Unit Objectives
At the end of this unit, participants will be able to:
• List the qualities of an effective leader
• Discuss the benefits of effective leadership
• List the traits of an effective team

Resources to be Used
• Participant Handbook
• Blank sheets of paper
• Pens

Do
• Show the picture given below to the class.
• Ask them to quickly write on a piece of paper what comes to their mind after seeing the picture.
• Now ask them, “What do you understand from this picture?”
• Encourage participants to share their thoughts.

Say
• This picture depicts the qualities of a leader and the difference between a leader and a boss.
• A boss focuses on structure and inspires fear whereas a leader follows vision and generates enthusiasm.
• A boss blames employees for the breakdown whereas a leader fixes breakdowns.
• A boss depends on authority whereas a leader depends on goodwill.
• A boss says “I” and a leader says “We.”
• A boss drives employees whereas a leader coaches them.
• A boss takes credit whereas a leader gives credit.

Say
• Talk about leadership and leadership qualities for an entrepreneur as discussed in the Participant Handbook.

Ask
• Why is it important for a leader to be effective? How does it help the organization?
Team Activity

Long Chain
- This is a group activity.

Do
- Divide the class into 2 teams.
- Ask each team to create a chain using materials they have in class such as shoe laces, belts, paper, handkerchief, ribbons, etc.
- The team that creates the longest chain wins the game.
- Observe if the participants are interacting with their team or working in isolation.
- Share your observations with the class.

Say

De-brief:
- What did the winning team do differently?
- Who was responsible for the winning team's success?
- How does this activity explain the role of teamwork in entrepreneurial success?

Say

- Tell the class that both the teams performed well.
- Discuss that the objective of this activity was to open communication channels and how this has been achieved.
- The participants should aim to keep the communication channels open when interacting with their peers and team members.
- It will set the pace and enthusiasm required for all the ensuing teamwork activities.
- Talk about teamwork and importance of teamwork in entrepreneurial success as discussed in the Participant Handbook.

Summarize

- Close the discussion by summarizing about the importance of teamwork for employees.
  - Teamwork helps in reducing stress for the employees.
  - Teamwork helps employers in generating more number of solutions to a problem and developing improved communication amongst employees.
- Ask the participants what they have learned from these exercises.
- Ask if they have any questions related to what they have talked about so far.

Ask

- Do you consider yourself a team player?
UNIT 10.5.3: Communication Skills: Listening & Speaking: The Importance of Listening Effectively

Unit Objectives

At the end of this unit, participants will be able to:

- Discuss the importance of listening effectively
- Discuss how to listen effectively
- Discuss the importance of speaking effectively
- Discuss how to speak effectively

Resources to be Used

- Participant Handbook

Activity 1

Activity – Chinese Whisper

Step 1: Form a circle.

Step 2: Start a whisper chain. Any one participant will whisper a message into his/her neighbour’s ear. No one else must hear the message. The message can be serious or downright silly.

Step 3: The next person who first heard the message should whisper the message very quickly to the person sitting next to them.

Step 4: The game goes on until the last person says whatever they heard out loud and the first person reveals the real message.

Compare them and have a great laugh!

Ask

De-brief questions:

- Was the original message the same as the message that is communicated at the end of the game?
- Why do you think there was a difference in the messages?

Say

- No, the original message was not same at the end of game.
- The barriers to communication like language, disturbance and noise, poor listening skills, boredom, poor speaking skills, etc. are the potential reasons this happens.
- There are various aspects to communication. Speaking skills and listening skills are two major components to any communication. There is always some room for improvement in the way we communicate.
- It is important to accept the reality of miscommunication and work to minimise its negative impacts.
Say

• Communication is a two-way process where people exchange information or express their thoughts and feelings.
• It involves effective speaking and effective listening.
• If I go to the store to get bread, I exchange money for the bread. I give something and get something in return. Communication takes place in the same manner. You have to provide and receive information for communication to take place.

Ask

• How often do you hear these statements?
  • “You're not listening to me!”
  • “Why don’t you let me finish what I’m saying?”
  • “You just don’t understand!”
• What do you think the other person is trying to convey to you through these sentences?
• We will not talk about the importance of listening effectively as discussed in the Participant Handbook.

Say

• Let's play a game to understand effective listening process better.

Do

• This is a class activity.
• The participants need to answer the questions they hear.
• Instruct them to listen carefully.
• You will read it at a stretch and if need be repeat it once more.
• Tell the participants to raise their hand if they know the answer to the question asked.
• Keep a check on time.

Activity 2

Riddles:

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is there any law against a man marrying his widow’s sister?</td>
<td>No.</td>
</tr>
<tr>
<td>If you went to bed at eight o’clock at night and set the clock’s alarm to ring at nine o’clock, how many hours of sleep would you get?</td>
<td>9 hours</td>
</tr>
<tr>
<td>Do they have a 26th of January in England?</td>
<td>Yes.</td>
</tr>
<tr>
<td>If you had only one match and entered a dark room that had a kerosene lamp, oil heater, and a wood stove, what would you light first?</td>
<td>Lamp</td>
</tr>
<tr>
<td>The Delhi Daredevils and the Chennai Super Kings play five IPL matches. Each wins three matches. No match was a tie or dispute. How is this possible?</td>
<td>Not possible</td>
</tr>
<tr>
<td>There was an airplane crash. Every single person died, but two people survived. How is this possible?</td>
<td>Due to the nature of the crash</td>
</tr>
<tr>
<td>If an airplane crashes on the border of two countries, would unidentified survivors be buried in the country they were travelling to or the country they were travelling from?</td>
<td>Country they were travelling to</td>
</tr>
<tr>
<td>A man builds an ordinary house with four sides except that each side has a southern exposure. A bear comes to the door and rings the doorbell. What is the colour of the bear?</td>
<td>Brown</td>
</tr>
</tbody>
</table>
Answers:

- There's no law against a man marrying his widow's sister, but it would be the neatest trick in the book since to have a widow, the man would have to be dead.
- You’d get one hour’s sleep since alarm clocks do not know the difference between morning and night.
- Oh, yes. They have a 26th of January in England. They also have a 27th, a 28th, and so on.
- First of all, you would light the match.
- Who said the Delhi Daredevils and the Chennai Super Kings were playing against each other in those games?
- Every SINGLE person died, but those two were married.
- You can’t bury survivors under any law especially if they still have enough strength to object.
- The bear that rang the doorbell would have to be a white bear. The only place you could build a house with four southern exposures is at the North Pole where every direction is in South.

Ask

De-brief question:
- What were the barriers that came into your way of listening?
- How can you overcome barriers to listening?

Say

- There is a difference between hearing and listening.
- If you don’t listen properly, the message may be misunderstood.
- Be open-minded while listening to someone.
- It is important to listen effectively and carefully without making assumptions.

Activity 3

Elevator Pitch:

You are in the lift of a hotel and you bumped into your former client who is a famous businessman. He has financed a lot of small business ventures and can finance your new start-up too. After exchanging pleasantries, he asks you what your new company does. You open your mouth, and then pause. Where do you even begin?

Then, as you try to organize your thoughts, his meeting is called, and he is on his way. If you would been better prepared, you’re sure that he would have stayed long enough to schedule a meeting with you too.

If you were given another chance, what would you have said to this person?

Do

- Start off the task by providing a beginning sentence to get the story started, and then go around the classroom getting each one to add a new sentence to keep the story going.
- This task should be done spontaneously allowing only a little time to think (30 seconds).
- For example: There was once a student who was looking for a job after graduation.
Tell the participants to follow these steps to create a great pitch, but bear in mind that you’ll need to vary your approach depending on what your pitch is about.

1. **Identify Your Goal:** Start by thinking about the objective of your pitch. For instance, do you want to tell the potential clients about your organization? Do you have a great new product idea that you want to pitch to an executive or do you want a simple and engaging speech to explain what you do for a living?

2. **Explain What You Do:** Start your pitch by describing what your organization does. Focus on the problems that you solve and how you help people. Ask yourself this question as you start writing: what do you want your audience to remember most about you? Keep in mind that your pitch should excite you first. After all, if you don’t get excited about what you’re saying neither will your audience. People may not remember everything that you say, but they will likely remember your enthusiasm.

3. **Communicate Your USP:** Your elevator pitch also needs to communicate your unique selling proposition or USP. Identify what makes you, your organization or your idea unique. You’ll want to communicate your USP after you’ve talked about what you do.

4. **Engage with a Question:** After you communicate your USP, you need to engage your audience. To do this, prepare open-ended questions (questions that can’t be answered with a "yes" or "no" answer) to involve them in the conversation. Make sure that you’re able to answer any questions that he or she may have.

5. **Put it all Together:** When you’ve completed each section of your pitch, put it all together. Then, read it aloud and use a stopwatch to time how long it takes. It should be no longer than 20-30 seconds. Remember, the shorter it is, the better!

**Example:**

Here’s how your pitch could come together:

"My company deals with cloth retail online business and we use various e-commerce platforms to sell our products. This means that you can do shopping with ease and spend time on other important tasks. Unlike other similar companies, we have a strong feedback mechanism to find out exactly what people need. This means that, on average, 95 percent of our clients are happy with our products. So, how can you help us in creating our own web portal?"

6. **Practice:** Like anything else, practice makes perfect. Remember, how you say it is just as important as what you say. If you don’t practice, it’s likely that you’ll talk too fast, sound unnatural or forget important elements of your pitch. Set a goal to practice your pitch regularly. The more you practice, the more natural your pitch will become. Practice in front of a mirror or in front of colleagues until the pitch feels natural.

**Summarize**

- Close the discussion by summarizing how to speak effectively as discussed in the Participant Handbook.
UNIT 10.5.4: Problem Solving & Negotiation Skills

Unit Objectives

At the end of this unit, participants will be able to:
- Discuss how to solve problems
- List the important problem solving traits
- Discuss ways to assess problem solving skills
- Discuss the importance of negotiation
- Discuss how to negotiate

Resources to be Used

- Participant Handbook

Ask

- What is a 'problem'?  
- What do you think are the problems you may face in the process of becoming a successful entrepreneur?

Say

- Discuss the definition of problem as given in the Participant Handbook.  
- In a hurdle race the hurdles are the obstacles on the way to reach your goal.  
- Similarly, obstacles are the hurdles you may face while reaching your goal i.e. to set-up your own business. Your goal will be to reach the finishing line after crossing these hurdles.

Ask

- What do you do when you face a problem?  
- How do you resolve it? You can pick examples from the question asked previously 'the problems they are likely to face in the process of becoming a successful entrepreneur'.

Say

- Discuss how to solve problems as given in the Participant Handbook.

Team Activity

- This is a group activity.  
- The groups will solve the problem and come up with the best solution in each case.
  1. Unable to arrange for some extra finance for setting up a beauty parlour. The loan sanctioned and disbursed is not enough. You have tried all your contacts, friends and relatives. But unable to manage the extra amount. Bank will not sanction more amount as you have used up the complete sanction limit.
  2. You have rented a space for your business and all arrangements are done. You will be operating from the office space rented in two days. Now the owner comes up to you and says he wants to sell the place and wants you to vacate in 15 days.
  3. You have just set up your business and need extra human resource. You have tried invieing a few also tied up with an agency for getting the right candidate. But you are unable to get the right candidate. If the candidate is good, you cannot offer the salary demanded. If the candidate agrees to the salary, he/she has other demands like working hours to be reduced, leaves etc. which may not work for your set up.
**Machining and Quality Technician**

**Do**

- Divide the class into three groups. Give one scenario to each group.
- Explain the purpose and duration of the activity.
- Ask the groups to build on the scenario and present their solution as a role play.

**Say**

**De-brief questions:**
1. What was the problem?
2. Is there any other alternative solution?
3. Is this the best solution presented?

**Ask**

- Try to think of some people around you who are able to solve problems very easily. Even you or your friends might be approaching them when there is a problem. What qualities do they have? What personality traits do such people possess?

**Say**

- Discuss the important traits for problem-solving as given in the Participant Handbook.

**Ask**

- In order to build a successful organization, you need to hire people who possess good problem solving skills. How would you assess the level of problem solving skills of potential candidates before hiring them?

**Say**

- Discuss how to assess for problem-solving skills as given in the Participant Handbook.

**Summarize**

- Ask the participants the things that they have learnt so far.
- Ask if they have any questions related to what they have talked about so far.
- Summarize the discussion on problem solving.

**Activity**

- The activity is to organise an election event. Select three volunteers from the group. They have to give a speech on their election manifesto to the class. They have to negotiate with the fellow participants and convince them to vote for them. The best negotiator will win the election.

**Do**

- Ask three participants to volunteer for the activity.
- Explain the purpose and duration of the activity.
- Set guidelines pertaining to discipline and expected tasks.
Facilitator Guide

Ask

- Out of the three contestants, whom would you support? Why? What did they say or do which convinced you to make your decision?
- Have you ever tried to negotiate in your personal or professional life?
- Ask the class to share some of their experiences where they have been able to strike a deal by negotiating.

Say

- Discuss “What is Negotiation?” as given in the Participant Handbook.

Ask

- Why is it important to negotiate? As an entrepreneur, where do you think that negotiation skills will be needed?

Say

- Discuss the importance of negotiation while starting a business as given in the Participant Handbook.

Say

- Discuss the important steps to negotiate as given in the Participant Handbook.

Role Play

- Conduct a role play activity.
- Ask the participants to assemble together.
- Explain the purpose and duration of the activity.
- Set guidelines pertaining to discipline and expected tasks.

Do

- Divide them into groups of four (4) (depending on the batch size).
- Give them the hand-outs for role play scenarios.
- Two groups to be given scenarios on problem solving.
- Other two groups to be given scenarios on negotiation.
- The groups will build on the scenarios and prepare for the role play.
- Give the groups at least 5 mins to discuss and be ready with the role play.
- Invite each group one by one to come and present their role play.

Problem solving Scenario 1

Avinash has a Mobile Repair Store in Allahabad. His outlet is one of the most popular one in the vicinity and he has great rapport with his customers. He is always well-dressed, jovial and full of energy.

It’s around 11 AM, when a customer barges in to the shop and starts shouting at Avinash for giving her back the instrument which is still not working. The screen of her mobile is also cracked from one side. Avinash remembered thoroughly checking the handset before handing it over to the customer. The customer threatens to sue the company and to go to Consumer Court for cheating her.
**Problem solving Scenario 2**
You are running a successful small scale business, Shreeji Aggarbattis. Your staff members do door to door selling and organise marketing campaigns in local markets. Your brand has established it's name in last few years.
Recently, lot of customers have been coming to you and lodging complaints that your staff members indulge in malpractices. Few of them informed you that a staff member engaged them in a friendly conversation. In the meanwhile, the other gave them lesser packets of aggarbattis than they paid for.
Another set of customers lodged complaint about the misconduct and rude behaviour of a particular staff member. You often hear from your customers that the orders don’t get delivered on time or wrong products get delivered. You have already been struggling with shortage of staff and such complaints are a serious concern as it is hampering your brand image. What strategies will you adopt to solve this problem?

**Negotiation Scenario 1**
You have interviewed a prospective new employee who could be a key member of your new entrepreneurial venture. The new person is demanding a salary that is 20% higher than you thought based on your business plan. Finances are tight, yet you believe this person could make a significant impact on future profits. If you paid the required salary for the new person, then you would have to restructure your entire business plan. You’ve been searching for an individual with this skill level for three months. to the candidate is waiting for your response. Now you have to call him in to make the final negotiations.

**Negotiation Scenario 2**
You are a young entrepreneur who has just registered his start up project and applied for a bank loan accordingly. You receive a letter saying that your loan application has been rejected as your start up idea did not appeal to the bank and they think that it is not a revenue generating model. You have taken an appointment to meet the manager and show your negotiation skills to get your loan approved.

**Notes for Facilitation**

**Facilitating Role Plays**

**Preparing for the activity**
1. Carefully review the details of the scenario and the character descriptions.
2. Become familiar with the key issues being addressed in the scenario.
3. Study the provided material so that you are ready to address issues related to the situations depicted in the role-plays.
4. Anticipate and know how to address issues participants might raise during the activity.

**Conducting the activity**
1. Introduce the activity. Emphasize that role-playing provides participants with an opportunity to apply their new knowledge, skills, and tools in situations that simulate actual interactions with customers.
2. Ask participants to form pairs. Direct the members of each group to choose who will play the roles. Remind the groups that each participant should be given the opportunity to play/practice the different roles.
3. Conduct a demonstration so that participants become familiar with the expectations related to the roles and support materials.
4. Give the pairs/groups 10 to 15 minutes to conduct the role-play (depending on the duration of the session).
5. After all the groups have finished with the role-play, conduct a debriefing session on each role-play.
6. Ask the groups to take five minutes to talk about what happened during the role-play. The groups should discuss the questions given in the debriefing for each role-play. Encourage participants to provide constructive criticism during their discussions.

**Summarize**

- Wrap the unit up after summarizing the key points and answering questions.
UNIT 10.5.5: Business Opportunity Identification: Entrepreneurs and Opportunities

Unit Objectives
At the end of this unit, participants will be able to:

- Discuss how to identify new business opportunities
- Discuss how to identify business opportunities within their business

Resources to be Used

- Participant Handbook
- Blank sheets of paper
- Pens

Ask

- How does an entrepreneur identify an opportunity?
- What do you think are the common queries or concerns faced by entrepreneurs?
- How can you identify new business opportunity?

Say

- Let’s talk about opportunity, common queries or concerns faced by entrepreneurs, idea as an opportunity, factors to consider when looking for opportunities, ways to identify new business, and opportunity analysis as discussed in Participant Handbook.
- Let’s do an activity to understand ways to identify business opportunities within your business.

Do

- Tell the class that this is an individual activity.
- Tell the participants to create a matrix on their notebooks.
- There will be four boxes in your matrix.
- Strength, Weakness, Opportunity and Threats will be the four headings of the matrix. This is called the SWOT matrix.
- Read out the questions to them and tell the participants they need to answer the questions asked in each matrix.
- Tell them they can also use their own understanding of themselves to fill the SWOT matrix.

Activity

Do your SWOT analysis

<table>
<thead>
<tr>
<th><strong>Strength</strong></th>
<th><strong>Weakness</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>What are your strengths?</td>
<td>What are your weaknesses?</td>
</tr>
<tr>
<td>What unique capabilities do you possess?</td>
<td>What do your competitors do better than you?</td>
</tr>
<tr>
<td>What do you do better than others?</td>
<td>What do others perceive as your strengths?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Opportunity</strong></th>
<th><strong>Threat</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>What trends may positively impact you?</td>
<td>Do you have solid financial support?</td>
</tr>
<tr>
<td>What opportunities are available to you?</td>
<td>What trends may negatively impact you?</td>
</tr>
</tbody>
</table>
Do

- Congratulate everyone for the class activity.
- Ask the audience to applaud for themselves.
- Allot the participants sufficient time to complete this activity, but do keep a check on time.
- Ask de-brief questions to cull out information from the participants.

Ask

**De-brief questions:**
- What are your weaknesses according to your SWOT analysis?
- Do you think you can change your weakness into strength? How?
- Do you think you can work on your threats? How?

Summarize

- Close the discussion by summarizing ways to identify business opportunities within your business.
- Ask the participants what they have learned from this exercise.
- Ask if they have any questions related to what they have talked about so far.
UNIT 10.5.6: Entrepreneurship Support Eco-System

Unit Objectives
At the end of this unit, participants will be able to:
• Explain the meaning of entrepreneur
• Describe the different types of entrepreneurs
• List the characteristics of entrepreneurs
• Recall entrepreneur success stories
• Discuss the entrepreneurial process
• Describe the entrepreneurship ecosystem
• Discuss the purpose of the 'Make in India' campaign
• Discuss the key schemes to promote entrepreneurs

Resources to be Used
• Participant Handbook
• Chart papers
• Marker pens
• Pencils
• Colour pencils
• Scale
• Eraser
• Other requisite stationery material

Ask
• Do you think that entrepreneurs need support?
• What do you think is an eco-system?
• What do you think 'entrepreneurship support eco-system' means?

Say
• Let's learn what entrepreneurship support eco-system means.
• Discuss 'Entrepreneurship Support Eco-System' as given in the Participant Handbook.

Ask
• Can you define entrepreneurship support eco-system?
• What are the key domains of the support eco-system?

Say
• Let's learn more about these domains by conducting an activity.
• You have to make a poster showing the components of the six main domains of entrepreneurship support eco-system.

Team Activity
• Making a poster showing the entrepreneurship support eco-system.
Do

- Divide the class into groups of four or six.
- Hand out chart paper and coloured pens.
- Explain the purpose and duration of the activity.
- Go around checking the progress of each group.
- Set guidelines pertaining to discipline and expected tasks.

**Activity De-brief**

Ask each group to display their poster and explain the key domains of entrepreneurship support eco-system.

![Diagram of entrepreneurship support eco-system]

**Ask**

- What kind of government support eco-system is available for entrepreneurs in India?

**Say**

- Discuss ‘Make in India’ campaign as given in the Participant Handbook.

**Team Activity**

- Presentation on key schemes to promote entrepreneurs

**Do**

- Divide the class into pairs.
- Number each pair from 1-15.
- Assign a scheme, same as their group number, to each group.
- Ask them to read the scheme carefully and present it to the class.
- Explain the purpose and duration of the activity.
- Go around checking the progress of each group.
- Set guidelines pertaining to discipline and expected tasks.

**Activity De-brief**

- Ask each group to explain the scheme offered by government to promote entrepreneurs.

**Summarize**

- Summarize the unit by discussing the key points and answering questions the participants may have.
UNIT 10.5.7: Risk Appetite & Resilience

Unit Objectives

At the end of this unit, participants will be able to:

- Discuss the relationship between entrepreneurship and risk appetite
- Discuss the relationship between entrepreneurship and resilience
- Describe the characteristics of a resilient entrepreneur

Resources to be Used

- Participant Handbook
- Chart papers
- Blank sheets of paper
- Pens
- Marker pens

Ask

- Can you define risk or explain what constitutes a risk?
- What do you people mean when they say, “This may be a risky proposition”?
- What risks are they talking about?

Example

- Let's have a look at these two examples:

  Rohit and his family were travelling by car from Delhi to Nainital. It was their second trip there. Rohit was familiar with the road. His friends told him that the highway after Rampur was in a bad condition. They advised him to take a shortcut and turn left from Moradabad and take the Kaladhungi road. This road is in a better condition.

  Since he was going with his family, and did want take the risk of getting lost, he left early. He took the Kaladhungi road and reached Nainital well in time.

  Suresh and his family too were travelling by car from Delhi to Nainital. It was their second trip there. His friends too advised him to take a shortcut and turn left from Moradabad and take the Kaladhungi road as this road was in a better condition.

  Suresh too decided to take the Kaladhungi road but he left Delhi in the afternoon. It was dark by the time he reached Kaladhungi, and he was sure that he was taking the correct turn. As it was late, he could not find anyone to give him directions. He ended up being in an unknown place that was scarcely inhabited.

Say

- Let's see what type of risks Rohit and Suresh took.
- Discuss 'Risk Appetite and Resilience' with the participants as given in the Participant Handbook.

Say

- Let's learn more about risk appetite and resilience with the help of an activity.
Risk Appetite

- This is a group activity.

- In the previous unit, you read success stories of Mr Dhirubhai Ambani and Dr Karsanbhai Patel.
- Mr Ambani left his job and started his company Reliance with just Rs. 50,000/-. 
- Dr Patel kept his job, went door-to-door to sell Nirma, and only when the brand started gaining popularity did he start his own company.
- What types of risk did both of them take?
- What risk factors, do you think, did they keep in mind before launching their company?
- Write the Risk Appetite Statement of both the companies.

Activity De-brief

- Who took a greater risk?
- What are the differences between the Risk Appetite Statement of both the companies?

Do

- Instruct the participants that this is group work.
- Divide the class into small groups of 4.
- Give each group a chart paper.
- Tell the participants that they have to evaluate the risks taken by Mr Dhirubhai Ambani and Dr Karsanbhai Patel.
- Give the participants 15 minutes to discuss and write.
- Keep a check on time. Tell the group to wind up quickly if they go beyond the given time limit.

Ask

- Do you think all entrepreneurial ventures are successful?
- What happens if the first venture is not successful?
- Should the entrepreneur stop when faced with challenges or face them?

Example

Let’s have a look at the following example:

Vijay Shekhar Sharma is the founder of Paytm, which is a giant Indian e-commerce. He was born in a middle-class family in Uttar Pradesh. He started his first job at an MNC. He quit after six months and built a company One97 with his friends. As One97 grew bigger, it needed more money because it was running more servers, bigger teams, and had to pay royalty. At that time, the tech bubble popped and technology companies were running in losses. Finally, money ran out. So One97 took loans and then more loans at higher rates of interest, as high as 24 per cent, and became caught in a vicious cycle.

In 2014, Paytm was launched with online wallet services after which, the company enabled online payment transactions. The company got licenses from RBI in 2016 to launch India’s first ever payment bank. Moreover, the main motive of Paytm was to transform India into a cashless economy.

After demonetization came into effect, Vijay Shekhar Sharma started promoting online and digital transactions to deal with the cash crunch. In fact, the service of the company’s mobile wallet is accepted across India. The logo of Paytm is now popular almost everywhere from tea stalls to major companies.
Let's see what qualities made Vijay Shekhar Sharma a resilient entrepreneur.

Discuss Entrepreneurship and Resilience with the participants as given in the Participant Handbook.

Let's learn more about entrepreneurship and resilience with the help of an activity.

This is a group activity.

Think of some entrepreneurship ventures that faced challenging times, but later resulted in success stories.

Who is the founder of that company?

What challenging times did it face?

How did it overcome those challenges?

List the resilient characteristics of the entrepreneur.

Each group to give their presentation.

Why did you choose this company?

What is the success story of the company?

Instruct the participants that this is group work.

Divide the class into small groups of 4.

Give each group a chart paper.

Tell the participants that they have to think of an entrepreneur who faced challenging times, but eventually succeeded.

Give the participants 15 minutes to discuss and write.

Keep a check on time. Tell the group to wind up quickly if they go beyond the given time limit.

You can summarize the key points of the unit.

Ask the participants what they learned from the activities.

Clarify any questions or doubts they might have.
UNIT 10.5.8: Success and Failures

Unit Objectives

At the end of this unit, participants will be able to:

• Discuss how to deal with failure

Resources to be Used

• Participant Handbook

Ask

• Have you heard the quote ‘nothing is impossible’?
• What do you think it means?
• Do you think that all successful entrepreneurs became famous overnight or did they have to struggle or face failure before succeeding?

Example

• Let’s have a look at this example.

Shah Rukh Khan, also known as, SRK or King Khan is a force to reckon with. Did he achieve stardom overnight? Shah Rukh Khan, who has seen many struggles in his life – he has slept on streets, struggled to support himself and his sister at a very young age, and lost his parents very early in life, which led to his sister seeking mental health support. Amidst all the chaos and challenges, he kept pushing himself, and today he stands tall as the ‘Badshah of Bollywood’. Certainly those years were not easy for him.

When he was young, he stood at Marine Drive and said, “I will rule this city one day”. Failure was not just his companion during or before his stardom, it is still a substantial part of his life. Success does not come easy. What made him a star was his acceptance of failure and the urge to improve.

Say

• How do you define success and failure?
• What is fear?
• Discuss “success and failure” with the participants as given in the Participant Handbook.

Ask

• Have you felt or experienced fear?
• What led you to feel that emotion?
• How did you handle it?

Say

• Let’s learn about success and failure with the help of an activity.
Team Activity

- Divide the class into groups of four.
- Instruct them to think of one scenario where they have to interview a successful entrepreneur.
- Explain the purpose and duration of the activity.
- Set guidelines pertaining to discipline and expected tasks.
- They have to choose one person from the group as the interviewee and one as the interviewer.
- Go around and make sure they have understood what is to be done and are discussing the roles properly.
- Check that everyone understands their role. Give clarifications if needed. Give the participants about 5 minutes to discuss and decide their roles.
- Ask the groups to stop the discussion as soon as the time is over.
- Invite each group one by one to come and present their interview as a role play.

Notes for Facilitation

Facilitating Role Plays

Preparing for the activity
1. Carefully review the details of the scenario and the character descriptions.
2. Become familiar with the key issues being addressed in the scenario.
3. Study the provided material so that you are ready to address issues related to the situations depicted in the role plays.
4. Anticipate potential questions that might be raised by the participants and be ready to address them.

Conducting the activity
1. Introduce the activity. Emphasize that role playing provides participants with an opportunity to apply their new knowledge, skills, and tools in situations that simulate actual interactions with customers.
2. Ask participants to form pairs. Direct the members of each group to choose who will play the roles. Remind the groups that each participant should be given the opportunity to play/practice the different roles.
3. Conduct a demonstration so that participants become familiar with the expectations related to the roles and support materials.
4. To maintain spontaneity of the interactions during the role play, ask the participants not to discuss the details of their roles prior to the role play.
5. Give the pairs 15-20 minutes to conduct the role play.
6. Circulate among the groups to answer any questions that may arise and provide guidance as needed.
7. After all the pairs have finished with the role play, conduct a de-briefing session on each role play.
8. Ask the groups to take five minutes to talk about what happened during the role play. The groups should discuss the questions given in the de-briefing for each role play. Encourage participants to provide constructive criticism during their discussions.
9. Conclude the activity by asking participants to think about whether and how they might use scripted role plays in their real life.

Summarize

- Wrap the unit up after summarizing the key points and answering questions.
UNIT 10.6: Preparing to be an Entrepreneur

Key Learning Outcomes

At the end of this unit, participants will be able to:

1. Discuss how market research is carried out
2. Describe the 4 Ps of marketing
3. Discuss the importance of idea generation
4. Recall basic business terminology
5. Discuss the need for CRM
6. Discuss the benefits of CRM
7. Discuss the need for networking
8. Discuss the benefits of networking
9. Discuss the importance of setting goals
10. Differentiate between short-term, medium-term and long-term goals
11. Discuss how to write a business plan
12. Explain the financial planning process
13. Discuss ways to manage your risk
14. Describe the procedure and formalities for applying for bank finance
15. Discuss how to manage their own enterprise
16. List the important questions that every entrepreneur should ask before starting an enterprise
UNIT 10.6.1: Market Study/ The 4Ps of Marketing/ Importance of an IDEA: Understanding Market Research

Unit Objectives

At the end of this unit, participants will be able to:
- Discuss how market research is carried out
- Describe the 4 Ps of marketing
- Discuss the importance of idea generation

Resources to be Used

- Participant Handbook
- Chart papers
- Markers pens
- Blank sheets of paper

Ask

- Suppose, you want to open a restaurant, what are the factors you will consider?
- How will you promote your restaurant?

Example

- Let’s have a look at this example.
  Arjun was an MBA working in a company. But he wanted to start a low cost budget hostel for foreign tourists coming to India. He did a lot or market research before starting the project. Based on the information he gathered, he made his business plan. His hostel is now flourishing and he is thinking of expanding to other tourist destinations.

Say

- Discuss “Market Study” with the participants. Refer to the Participant Handbook.
- Let’s learn about market study and research with the help of an activity.

Team Activity

Market Study
- This is a group activity.
- You want to start your own tuition centre.
- What type of research will you do?

Activity De-brief
- Ask each group to come forward and give a brief presentation.
- Encourage other groups to be interactive and ask questions.
- What factors did you keep in mind while doing your research?
- Based on our research would you go ahead and open a tuition centre?
By opening a tuition centre you are offering a service.

What factors will you keep in mind before opening it?

Discuss “The 4Ps of Marketing” with the participants as given in the Participant Handbook.

Let’s learn about the 4Ps of Marketing with the help of an activity.

**4 Ps of Marketing**
- This is a group activity.
- You have to sell a pen to four different segments:
  1. Rural villagers
  2. Rural middle class
  3. Urban middle class
  4. Upper end rich people (Niche market)

Keeping the 4Ps of Marketing in mind, what marketing strategy will you design to sell the pen?

**Activity De-brief**
- Ask each group to present their strategy.
- Encourage other groups to be interactive and ask questions.

Instruct the participants that this is group work.
Divide the class into small groups of 4 or 6.
Give each group a chart paper.
Tell the participants that they have to start their own tuition centre.
Give the participants 10 minutes to discuss and write the research work they need to do.
Keep a check on time. Tell the group to wind up quickly if they go beyond the given time limit.

Instruct the participants that this is group work.
Divide the class into four groups.
Give each group a chart paper.
Assign each group a target audience for selling the pens:
  1. Rural villagers
  2. Rural middle class
  3. Urban middle class
4. Upper end rich people
- Tell the participants that they have to design a marketing strategy keeping the 4Ps of Marketing in mind.
- Give the participants 20 minutes to discuss and come up with their strategy.
- Keep a check on time. Tell the group to wind up quickly if they go beyond the given time limit

Activity De-brief
- Ask each group to come forward and give a brief presentation.
- Ask each group what they kept in mind while designing their marketing strategy.
- Encourage other groups to be interactive and ask questions.

Say
- Each entrepreneur has an idea of wants he wants to sell. It may be a service or a product.
- Discuss “Importance of an IDEA” as given in the Participant Handbook.

Summarize
- Summarize the key points of the unit.
- Ask the participants what they learnt from the activities.
- Encourage them to ask if they have any doubts.
UNIT 10.6.2: Business Entity Concepts

Unit Objectives

At the end of this unit, participants will be able to:

- Recall basic business terminology

Resources to be Used

- Participant Handbook

Say

- Let's recall some basic business terminology.
- Discuss the Business Entity Concepts as given in the Participant Handbook.
- Let's learn some basic business terminology by having an activity.
- We will have a quiz today.

Activity

- The activity is a quiz.

Do

- Divide the class in two groups and give a name to each group.
- Explain the rules of the quiz. For each correct answer the group gets 1 mark.
- If the group is unable to answer the question is passed to the next group.
- Explain the purpose and duration of the activity.
- Ask the questions of the quiz.
- Keep a score of the groups.
- Set guidelines pertaining to discipline and expected tasks.

Summarize

- Summarize the unit by discussing the key points.

Questions for Facilitation

QUESTIONS FOR THE QUIZ
1. What does B2B mean?
   - Business to business
2. What is a financial report?
   - A comprehensive account of a business' transactions and expenses
3. Who is a sales prospect?
   - A potential customer
4. How is working capital calculated?
   - Current assets minus current liabilities
5. What is an estimation of the overall worth of a business called?
   Valuation

6. You are buying a house. What type of transaction is it?
   Complex transaction

7. How will you calculate the net income?
   Revenue minus expenses

8. How is Return on Investment expressed?
   As percentage

9. How will you calculate the cost of goods sold?
   Cost of materials minus cost of outputs

10. What is revenue?
    Total amount of income before expenses are subtracted.

11. What is a Break-Even Point?
    This is the point at which the company will not make a profit or a loss. The total cost and total revenues are equal.

12. What is the formula used to calculate simple interest?
    \[ A = P(1 + rt); R = r \times 100 \]

13. What are the three types of business transactions?
    Simple, Complex and Ongoing Transactions

14. The degrading value of an asset over time is known as
    Depreciation

15. What are the two main types of capital?
    Debt and Equity
UNIT 10.6.3: CRM & Networking

Unit Objectives

At the end of this unit, participants will be able to:
- Discuss the need for CRM
- Discuss the benefits of CRM
- Discuss the need for networking
- Discuss the benefits of networking

Resources to be Used

- Participant Handbook

Ask

- Can your business run without customers/buyers?
- Who is the most important entity in any business?

Say

- The key to every success business lies on understanding the customer’s expectations and providing excellent customer service.
- Discuss about CRM and its benefits. Refer to the Participant Handbook.
- Providing excellent customer service entails:
  - Treating your customers with respect.
  - Be available as per their need/schedule.
  - Handling complaints effectively.
  - Building long-lasting relationships.
  - Collecting regular feedback.
- Handle customer complaints proactively. Ask “what happened”, “why it happened”, “how can it be avoided next time”, etc.
- Collecting feedback from the customers regularly will enable you to improve your good/service.
- “Let's understand it better with the help of some case scenarios. You will be given some cases within your groups. You have to analyse the case scenario that has been given to you and then find an appropriate solution to the problem.”

Do

- Divide the class into four groups of maximum six participants depending on the batch size.
- Give one case study to each group.
- Instruct them to read the case carefully.
- The group is expected to analyse and discuss the case amongst them and find a solution to the given problem.
- Put down the discussion points (de-brief questions) on the board. Give the class 5-10 minutes to discuss the case and note down their solutions.
- At the end of 10 minutes, the team should present their case solution to the class.
Case Study Analysis
Raju runs a business of wooden furniture. He has a huge list of customers on Facebook and WhatsApp who give him orders regularly. Ankita is one of his old and regular customers. She placed an order for a new chester and TV cabinet via WhatsApp and requested Raju to send them as soon as possible. When the parcel reached Ankita through courier she found that chester was broken and the TV unit was chipped from the bottom. Ankita was heartbroken. It was a complete waste of money. She sent a message to Raju on WhatsApp, expressing her anger and disappointment. Raju might lose an old customer forever if he doesn’t satisfy the customer. What should Raju do to retain his customer?

Scenario 2
Rajni runs a boutique shop. She sells suits and sarees. She is one of the most successful designer in her city. Rajni swears that all the clothes in her boutique have unique designs. Smita has to attend her cousin’s wedding; she goes to Rajni’s boutique to buy a saree. Smita wanted a unique designer saree. Rajni customized a saree for her and sent it over the courier. When Smita had a look at the saree she realised her two friends had the same design sarees. She sent a message to Rajni on WhatsApp, expressing her anger and disappointment. Did Rajni make a false promise? Were her designs copied? What could happen to Rajni’s image after this incident? What would you do if you were in Rajni’s place?

Scenario 3
Shama is a beautician who offers parlour services to ladies by making home visits. Recently, Shama got her name registered on an e-commerce website. Two days earlier, she got a message from Mrs Sushma. The appointment was fixed for next day, 11:00 am and the remuneration for the services was decided beforehand. When Shama reached there at 10:50 am, Mrs Sushma was not at home. When Shama called her, she asked her to wait for a while. Mrs Sushma reached home at 11:45 am. Meanwhile, Shama had to reschedule her next appointment. After availing Shama’s services, Mrs Sushma refused to pay the requisite amount and started finding faults in the services provided by her. Who was at fault in this scenario? What should you do in case the customer behaves unreasonably? What would you do if you were in Shama’s place?

Scenario 4
Shailender is the manager of a car showroom. He proactively takes part in all the transactions that happen in his showroom. Vinita wants to buy a new car. She has chosen a car from Shailender’s showroom. The salesperson has given her a very good discount and has also promised free service for one year. Vinita goes to the showroom and asks to complete all the formalities to purchase the car. When she sees the final bill she realize that she has not received the promised discount neither was there any mention of the free services. She immediately demands to see the Shailender. When Shailender’s head asks how much discount Vinita was promised, he realised the discount will make the sale in loss. The car showroom owner might lose a customer and deal due to false commitments made by his manager. Besides, the customer might tell this to other people, creating a bad name and image for the showroom. If you owned that showroom, how would you have convinced your customer?

Say
- Now, let’s discuss the problem and solution with the class.
- The group will first briefly describe the case to the class.
- Then discuss the issue identified and the proposed solution.
- Present the solution as a role play.
- Post presentation, the other groups may ask questions from the group that has presented.
**Do**

- Congratulate each group for the presentation/role play.
- Ask the audience to applaud for them.
- Keep a check on time. Tell the group to wind up the discussion quickly if they go beyond the given time limit.

**Say**

- If your customers are happy with you they will give referrals which will help to grow your business.
- One more way of growing business is ‘Networking’.
- Discuss Networking and its benefits. Refer to the Participant Handbook.

**Activity**

**Group Discussion**

- Conduct a group discussion in the class on how they can do networking for their business.

**Summarize**

- Ask the participants what they have learnt from this exercise/activity.
- Ask if they have any questions related to what they have talked about so far.
- Close the discussion by summarizing the importance of CRM and Networking for entrepreneurs.
- Close the discussion by summarizing the importance of CRM and Networking for entrepreneurs.
UNIT 10.6.4: Business Plan: Why Set Goals?

Unit Objectives

At the end of this unit, participants will be able to:

- Discuss the importance of setting goals
- Differentiate between short-term, medium-term and long-term goals
- Discuss how to write a business plan
- Explain the financial planning process
- Discuss ways to manage your risk

Resources to be Used

- Participant Handbook
- Chart papers
- Blank papers
- Marker pens
- Ruler

Ask

- Remember we had written SMART Goals in a previous session? Let’s try and recall why it is important to set goals?
- While framing SMART goals, we talked about ‘T’ in SMART, which was ‘Time Bound’? What do we mean by time bound goals?
- What time limit did you set for your goal- 3 weeks, 3 years, 10 years?

Say

- Talk about short term, long term and medium term goals, as discussed in the Participant Handbook.

Ask

- As you are planning to become an entrepreneur, you must have thought of an idea for a start-up. What is your business idea?

Do

- Ask few participants to share their business ideas.

Ask

- Have you created a business plan for your business idea?
- Do you think it is important to have a business plan in place? Why/ why not?

Say

- Talk about ‘Why Create a Business Plan’ as discussed in the Participant Handbook.
- Let’s understand it better with the help of an activity.
Team Activity

Writing a business Plan

- This is a group activity.
- Give the groups the required resources such as chart paper and markers.
- This activity is divided into two parts:
  1. Create a business idea
  2. Develop a business plan
- The group will discuss and come up with a new business idea and present their idea to the class.
- In the second part of the activity the group will develop a business plan for the business idea.
- The business plan prepared will be presented by the groups to the class.

<table>
<thead>
<tr>
<th>MY BUSINESS PLAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive Summary: What is your Mission Statement?</td>
</tr>
<tr>
<td>Business Description: What is the nature of your business?</td>
</tr>
<tr>
<td>Market Analysis: What is your target market?</td>
</tr>
<tr>
<td>Organization and Management: What is your company’s organizational structure?</td>
</tr>
<tr>
<td>Service or Product Line: What is the lifecycle of your product/service?</td>
</tr>
<tr>
<td>Marketing and Sales: How will you advertise and sell your products?</td>
</tr>
<tr>
<td>Funding Request: How much fund is required and from where?</td>
</tr>
</tbody>
</table>

Say

- Teams will need to brainstorm for this part of the activity.
- Use the blank papers for the second part of this activity
- Make your business plan on a chart paper based on the following parameters:
  1. Executive Summary
  2. Business Description
  3. Market Analysis
  4. Organization and Management
  5. Service or Product Line
  6. Marketing and Sales
- Explain each parameter in detail as done in the Participant Handbook.
- Discuss each parameter with the business idea examples of the groups.
- Groups will discuss and develop the business plan for their business idea.
Do

- Congratulate each group for sharing their points.
- Ask the audience to applaud for them.
- Keep a check on time. Tell group to wind up the discussion quickly if they go beyond the given time limit.

Say

- Along with a business plan, you need to create a financial plan and evaluate the risk involved with your start up.

Summarize

- Ask the participants what they have learnt from this exercise/ activity.
- Ask if they have any questions related to what they have talked about so far.

Notes for Facilitation

- Keep the business plan format ready in a flipchart to display it during the activity.
UNIT 10.6.5: Procedures and Formalities for Bank Finance

Unit Objectives

At the end of this unit, participants will be able to:

- Describe the procedure and formalities for applying for bank finance

Resources to be Used

- Participant Handbook
- Bank loan/finance form sample

Ask

- While preparing a business plan in the last session, we discussed financial planning to arrange financial resources for your start-up. Therefore, how will you collect funds to start your business?

Say

- While most entrepreneurs think 'product' is the most difficult thing to decide for a business, start-up capital poses an even bigger obstacle. Though there are various ways of funding the business, to convince investors to invest money is the most challenging.

- Some of the funding options available in India are:
  - **Bootstrapping**: Also called self-financing is the easiest way of financing
  - **Crowd funding**: Funds are collected by consumers pre-ordering or donating for starting the business.
  - **Angel investors**: Individual or group of investors investing in the company
  - **Venture capitalists**: Venture capitals are professionally managed funds who invest in companies that have huge potential. They usually invest in a business against equity.
  - **Bank loans**: The most popular method in India.
  - **Microfinance Providers or NBFCs**
  - **Government programmes**
- Let us know discuss the most popular method i.e. bank finance in detail here.

Do

- Discuss the list of documents that are required to apply for a loan like letter of introduction, business brochure, references of other banks, and financial statements.
- Explain the details to be filled in a loan application form.
- Divide the class into groups. Give each group a loan application form.
- Ask the groups to discuss and fill the form.

Summarize

- Close the discussion by summarizing the important documents needed for bank loan.
- Ask the participants if they have any questions related to what they have talked about so far.
Notes for Facilitation

- Checklist of documents is provided as resources for the session.
- You can make some copies and distribute it during the group activity.
- Download sample loan application forms from any nationalised bank's website. Print sufficient copies to circulate it amongst the groups.

<table>
<thead>
<tr>
<th>CHECKLIST OF DOCUMENTS TO BE SUBMITTED ALONG WITH LOAN APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Common for all banks</strong></td>
</tr>
<tr>
<td>1. Audited financial statements of the business concern for the last three years</td>
</tr>
<tr>
<td>2. Provisional financial statements for the half – year ended on ________________</td>
</tr>
<tr>
<td>3. Audited financial statements of associate concern/s for the last three years</td>
</tr>
<tr>
<td>4. Copy of QIS II for the previous quarter ended on ____________</td>
</tr>
<tr>
<td>5. Operational details in Annexure I</td>
</tr>
<tr>
<td>6. CMA data for the last three years, estimates for current year and projection for the next year</td>
</tr>
<tr>
<td>7. Term loan/DPG requirements in Annexure II</td>
</tr>
<tr>
<td>8. List of machinery in respect of machinery offered as security in Annexure III</td>
</tr>
<tr>
<td>9. Additional details for export advances furnished in Annexure IV</td>
</tr>
<tr>
<td>10. Property statements of all directors/partners/proprietor/guarantors</td>
</tr>
<tr>
<td>11. Copies of ITAO of the company for the last three years</td>
</tr>
<tr>
<td>12. Copies of ITAOs/WTAOs of the directors/partners/proprietor and guarantors</td>
</tr>
<tr>
<td>12. Copies of certificate from banks and financial institutions certifying the latest liability with them</td>
</tr>
<tr>
<td>14. Copy of board resolution authorizing the company to apply to your bank for the credit facilities mentioned in application</td>
</tr>
<tr>
<td>15. Copy of memorandum and article of association (in case of limited company)/partnership deed (in case of partnership firm)</td>
</tr>
<tr>
<td>16. Cash budget for the current year and next year in case of contractors and seasonal industries</td>
</tr>
</tbody>
</table>
UNIT 10.6.6: Enterprise Management – An Overview: How to Manage Your Enterprise?

Unit Objectives
At the end of this unit, participants will be able to:
• Discuss how to manage their own enterprise

Resources to be Used
• Participant Handbook

Ask
• Having set-up a business, do you think it is possible to do everything on your own?
• Does one require trained persons for help?
• What does management mean?

Say
• Let’s have a look at this example:
  Kapil had a small business that was beginning to pick up pace. He wanted to expand his business, and therefore employed few more people. One day, as he was walking past Ramesh, one of his new employees, he overheard Ramesh talking rudely to a customer on the phone. This set him thinking. Kapil realised that he should have regular team meetings to motivate his employees and speak with them about any problems they might be facing during work. He should also conduct training sessions on new practices, soft skills, and technology, and develop work ethics manual for managing his enterprise.

Say
• Was Kapil correct in his approach or he should have scolded Ramesh instantly in front of his other employees?
• Discuss “Enterprise Management – An Overview” with the participants as given in the Participant Handbook.

Say
• Let’s learn how to effectively manage an enterprise or business through an activity.

Team Activity
Enterprise Management
• This is a group activity.
• Design a matrix listing the topics and key words that are needed to run an enterprise effectively and smoothly.

Activity De-brief
• Have each group present their matrix.
• Encourage participants of the other groups to ask question about each other’s presentation.
Facilitator Guide

Do

- Instruct the participants that this is group work.
- Divide the class into small groups of 4.
- Give each group a chart paper and coloured pen.
- Tell the participants that they have make a matrix they need to fill.
- They have to write the main topics and key words that will them effectively manage their enterprise.
- Give the participants 15 minutes to discuss and write.
- Keep a check on time. Tell the group to wind up quickly if they go beyond the given time limit.

Summarize

- Ask the participants what they have learned from this exercise/activity.
- Ask if they have any questions related to what they have talked about so far.
- Close the discussion by summarizing the importance of effective management to run an enterprise as given in the Participant Handbook.
UNIT 10.6.7: 20 Questions to Ask Yourself before Considering Entrepreneurship

Unit Objectives
At the end of this unit, participants will be able to:
- List the important questions that every entrepreneur should ask before starting an enterprise

Resources to be Used
- Participant Handbook
- Blank sheets of paper
- Pens

Ask
- Why do you want to become an entrepreneur?

Say
- It is very important to know why you want to become an entrepreneur. Your personal goals for becoming an entrepreneur play a key role in the success of your business. Your goals should be clear well before you start your business.
- Apart from the goals, the other aspects of business that you need to bear in mind are the potential problems that you may face to set-up, your areas of interest, and all the other dimensions of the business.
- Let’s understand it better with the help of some questions that every entrepreneur should ask before starting their own business.
- Open the Participant Handbook section named ‘20 Questions to Ask Yourself Before Considering Entrepreneurship’. You have to answer the questions individually.
- Then, we will have a class discussion on all the questions.

Do
- Read out the questions one by one in front of all the participants.
- Participants have to answer all the one by one questions.
- Give the class 10-15 minutes to note down their answers.
- At the end of 15 minutes, open the discussion for all the questions.
- Moderate the discussion by focusing on the relevant points.
- Keep a check on time and don’t let the discussion get sabotaged or lose track of time. Ensure all the questions are covered and discussed.

Summarize
- Ask the participants what they have learned from this exercise/activity.
- Ask if they have any questions related to what they have talked about so far.
11. Annexures

Annexure I: Training Delivery Plan
Annexure II: Assessment Criteria
Annexure I
Training Delivery Plan

Training Delivery Plan

<table>
<thead>
<tr>
<th>Program Name:</th>
<th>Certificate Course in Machining and Quality Technician</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualification Pack Name &amp; Ref. ID</td>
<td>Machining and Quality Technician - ACS/Q3509</td>
</tr>
<tr>
<td>Version No.</td>
<td>1.0</td>
</tr>
<tr>
<td>Version Update Date</td>
<td>7-03-2017</td>
</tr>
<tr>
<td>Pre-requisites to Training (if any)</td>
<td>Class 10th /I.T.I in Mechanical/Electrical</td>
</tr>
</tbody>
</table>

Training Outcomes

By the end of this program, the participants will be able to:

1. Understand the component requirements and the equipment to be used
2. Set up the machine as per the work instructions/ guidance from the machinist/ Supervisor
3. Support the machinist/ operator/supervisor in various kinds of machining operations
4. Record the observations during the process
5. Perform minor machine maintenance activities
6. Perform de-burring activity on the machined components
7. Assist the operator in the tool change process
8. Perform complete dimensional, layout inspection and visual check as per product drawing
9. Document the observations in the inspection check sheet
10. Handle inspection equipment and instruments such as Vernier Micrometer, height gauge and air gauges and similar other items
11. carry out dock audit consisting of visual, labelling and packaging checks
12. Create and sustain a safe , clean and environment friendly workplace
13. Identified activities which can cause potential injury through sharp objects , gas leakage, burns poisons fumes etc.
14. Ensure sorting, streamlining and organizing, storage and documentation, cleaning, standardization and sustenance across the plant and office premises of the organization.

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Module Name</th>
<th>Session Name</th>
<th>Session Objectives</th>
<th>NOS Reference</th>
<th>Methodology</th>
<th>Training Tools/ Aids</th>
<th>Duration</th>
</tr>
</thead>
</table>
| 1.     | Introduction | Icebreaker   | • General Discipline in the class room  
• General Safety Rules | Group Activity: Passing the Parcel | • Class Room Size  
• Chairs/Tables  
• Computer with Internet | 8 hour |
<p>| 2. <strong>Assist in Carrying out pre-machining activities</strong> | Understanding engineering drawing, basic principle of 5S, reading SOP’s, work instructions, control panel instructions etc. | • Understanding the component requirements and the equipment to be used ASC/N3504 PC1, PC2, PC3, PC4, PC5, PC6, PC7 KB1, KB2, KB3, KB4, KB5 SA1, SA2, SA3, SA4, SA5, SA6, SA7 SB1, SB2, SB3, SB4, SB5, SB6, SB7, SB8, SB9, SB10, SB11 | • Facilitator-led-discussion • Skill Practice (Activity) | • Teaching Aids: Charts, CBTs, Videos, White board Markers, White board / Flip charts. • Basic Tool Box Machining Technician • Machining Tools/equipment: Surface marking plate, cutting tools, threading, dies &amp; guides, etc. Conventional lathe with Standard accessories • Vertical Milling machine with standard accessories | 8 hrs 8 hrs 8 hrs |</p>
<table>
<thead>
<tr>
<th>Understanding the does and don’ts of the manufacturing process as defined in SOPs/ Work Instructions or defined by supervisors</th>
<th>Understanding the does and don’ts of the manufacturing process as defined in SOPs/ Work Instructions or defined by supervisors</th>
<th>Understanding the tooling instructions as specified in the Operating Manual/ Work Instructions or Standard Operating Procedures</th>
<th>Understanding the tooling instructions as specified in the Operating Manual/ Work Instructions or Standard Operating Procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 hrs</td>
<td>8 hrs</td>
<td>8 hrs</td>
<td>8 hrs</td>
</tr>
</tbody>
</table>

- **Bench Drilling machine with standard accessories**
- **Bench grinder**
- **Work bench with vice**
- **Production CNC lathe**
- **Production CNC machining centre with ATC**
- **Compressor, stabilisers**
- **Measuring Equipment:** vernier calipers, micrometre, feeler gauges, bore gauge, slip gauge, thickness gauge, steel ruler, measuring tape, height, gauge, dial gauge, angle plate, set square compass, calipers etc.
- **Coolant, oils and lubricants used**
- **Operating Manual**
<table>
<thead>
<tr>
<th>Machining and Quality Technician</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Understanding the tooling instructions as specified in the Operating Manual/Work Instructions or Standard Operating Procedures</td>
</tr>
<tr>
<td>• Understanding the tooling instructions as specified in the Operating Manual/Work Instructions or Standard Operating Procedures</td>
</tr>
<tr>
<td>• Selection of proper coolant and lubricant required for machining the required component</td>
</tr>
<tr>
<td>• Selection of proper coolant and lubricant required for machining the required component</td>
</tr>
</tbody>
</table>

| Personal Protection Equipment: Gloves, Safety Shoes, goggles, ear plugs, |
| Workshop Safety: Fire extinguishers |
| First Aid |
| Safety signs |
| SOP Charts on safety norms and drills |
| Charts of dos and Don’ts in work area. |
| Sample work pieces: Automotive casting, Forged parts, Powder coating part, Welded parts, Sub assembly parts |
| Sample of machined parts |
| Machine drawing Handbooks |
| Consumables: Oil stones, Emery, Dressing stone, File cord, Tool post packing, Spares for cutting tools, |

| 8 hrs |
| 8 hrs |
| 5 hrs |
### 3. Support the operator in performing machining operations

| Machine setting, adjusting machine tools, aligning and holding fixtures, cutting tools, start lathe or turning/milling machine for operations, operate hand wheels or valves in order to feed the component and allow cooling and lubricating | • Set-up, adjust machine tools in order to perform machining operations and keep dimension within the specified tolerance limit  
- KB1, KB2, KB3, KB4  
- SA1, SA2, SA3, SA4, SA5, SA6, SA7, SA8  
- SB1, SB2, SB3, SB4, SB5, SB6, SB7, SB8, SB9, SB10, SB11, SB12, SB13, SB14  
- ASC/N3505 PC1, PC2, PC3, PC4, PC5, PC6, PC7, PC8, PC9, PC10, PC11 | • Facilitator-led-discussion  
• Skill Practice (Activity)  
• Teaching Aids: Charts, CBTs, Videos, White board Markers, White board / Flip charts.  
• Basic Tool Box Machining Technician  
• Machining Tools/equipment: Surface marking plate, cutting tools, threading, dies & guides, etc. Conventional lathe with Standard accessories  
• Vertical Milling machine with standard accessories  
• Bench Drilling machine with standard accessories  
• Bench grinder | 8 hrs  
8 hrs  
8 hrs |
<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support the operator in aligning and securely holding fixtures, cutting tools etc. onto the machine</td>
<td>8 hrs</td>
<td></td>
</tr>
<tr>
<td>Support in selecting cutting tools and tooling instructions as per the work instructions / supervisor’s instructions</td>
<td>8 hrs</td>
<td></td>
</tr>
<tr>
<td>Support in selecting cutting tools and tooling instructions as per the work instructions / supervisor’s instructions</td>
<td>8 hrs</td>
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<tr>
<td>Support in selecting cutting tools and tooling instructions as per the work instructions / supervisor’s instructions</td>
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<td></td>
</tr>
<tr>
<td>Work bench with vice</td>
<td>8 hrs</td>
<td></td>
</tr>
<tr>
<td>Production CNC lathe</td>
<td>8 hrs</td>
<td></td>
</tr>
<tr>
<td>Production CNC machining centre with ATC</td>
<td>8 hrs</td>
<td></td>
</tr>
<tr>
<td>Compressor, stabilisers</td>
<td>8 hrs</td>
<td></td>
</tr>
<tr>
<td>Measuring Equipment: vernier calipers, micrometre, feeler gauges, bore gauge, slip gauge, thickness gauge, steel ruler, measuring tape, height, gauge, dial gauge, angle plate, set square, compass, calipers etc.</td>
<td>8 hrs</td>
<td></td>
</tr>
<tr>
<td>Coolant, oils and lubricants used</td>
<td>8 hrs</td>
<td></td>
</tr>
<tr>
<td>Operating Manual</td>
<td>8 hrs</td>
<td></td>
</tr>
<tr>
<td>Personal Protection Equipment: Gloves, Safety Shoes, goggles, ear plugs,</td>
<td>8 hrs</td>
<td></td>
</tr>
</tbody>
</table>
- Observe machine operations to detect defects in the component manufactured

- Observe machine operations to detect defects in the component manufactured

- Observe machine operations to detect defects in the component manufactured

- Observe the machine operations for any malfunctions and immediately inform the supervisor of any malfunction observed

- Observe the machine operations for any malfunctions and immediately inform the supervisor of any malfunction observed

- Observe the machine operations for any malfunctions and immediately inform the supervisor of any malfunction observed

- Workshop Safety: Fire extinguishers
- First Aid
- Safety signs
- SOP Charts on safety norms and drills
- Charts of dos and Don’ts in work area.
- Sample work pieces: Automotive casting, Forged parts, Powder coating part, Welded parts, Sub assembly parts
- Sample of machined parts
- Machine drawing Handbooks
- Consumables: Oil stones, Emery, Dressing stone, File cord, Tool post packing, Spares for cutting tools, Carbide inserts, Grinding Wheels etc.

<table>
<thead>
<tr>
<th>Work</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workshop Safety: Fire extinguishers</td>
<td>8 hrs</td>
</tr>
<tr>
<td>First Aid</td>
<td>8 hrs</td>
</tr>
<tr>
<td>Safety signs</td>
<td>8 hrs</td>
</tr>
<tr>
<td>SOP Charts on safety norms and drills</td>
<td>8 hrs</td>
</tr>
<tr>
<td>Charts of dos and Don’ts in work area.</td>
<td>8 hrs</td>
</tr>
<tr>
<td>Sample work pieces: Automotive casting, Forged parts, Powder coating part, Welded parts, Sub assembly parts</td>
<td>8 hrs</td>
</tr>
<tr>
<td>Sample of machined parts</td>
<td>8 hrs</td>
</tr>
<tr>
<td>Machine drawing Handbooks</td>
<td>8 hrs</td>
</tr>
<tr>
<td>Consumables: Oil stones, Emery, Dressing stone, File cord, Tool post packing, Spares for cutting tools, Carbide inserts, Grinding Wheels etc.</td>
<td>8 hrs</td>
</tr>
<tr>
<td>Hand book, job orders, work order, completion material requests, and Technical Reference Books.</td>
<td>5 hrs</td>
</tr>
<tr>
<td>4. Support the operator in conducting all post machining operations</td>
<td>Minor machine maintenance activities, adding coolant and lubricant, use files, hand grinders, wire brushes, or power tools for performing de-burring operation, using measuring instruments</td>
</tr>
<tr>
<td>• Perform minor machine maintenance activities such as oiling or cleaning machine and its components</td>
<td>• Perform minor machine maintenance activities such as oiling or cleaning machine and its components</td>
</tr>
<tr>
<td>• Perform minor machine maintenance activities such as oiling or cleaning machine and its components</td>
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</tr>
</tbody>
</table>

8 hrs 8 hrs 8 hrs 8 hrs
- Perform minor machine maintenance activities such as oiling or cleaning machine and its components

- With the help of the correct tool remove the extra burrs, sharp edges, rust and chips from the metal surface

- With the help of the correct tool remove the extra burrs, sharp edges, rust and chips from the metal surface

- With the help of the correct tool remove the extra burrs, sharp edges, rust and chips from the metal surface

- Coolant, oils and lubricants used
- Operating Manual
- Personal Protection Equipment: Gloves, Safety Shoes, goggles, ear plugs,
- Workshop Safety: Fire extinguishers
- First Aid
- Safety signs
- SOP Charts on safety norms and drills
- Charts of dos and Don’ts in work area.

<table>
<thead>
<tr>
<th>Tool Types</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calipers, micrometre, feeler gauges, bore gauge, slip gauge, thickness gauge, steel ruler, measuring tape, height, gauge, dial gauge, angle plate, set square compass, calipers etc.</td>
<td>8 hrs</td>
</tr>
<tr>
<td>Coolant, oils and lubricants used</td>
<td>8 hrs</td>
</tr>
<tr>
<td>Operating Manual</td>
<td>8 hrs</td>
</tr>
<tr>
<td>Personal Protection Equipment:</td>
<td>8 hrs</td>
</tr>
<tr>
<td>Gloves, Safety Shoes, goggles, ear plugs, Workshop Safety: Fire extinguishers First Aid Safety signs SOP Charts on safety norms and drills Charts of dos and Don’ts in work area.</td>
<td>8 hrs</td>
</tr>
</tbody>
</table>
| 5. | **Inspect and maintain the product quality** | Inspection of final product, inspection methods, reporting and documentation of damage material | Conduct an inspection of a part covering the following check points
- Visual inspection of the part for scratches, dents, damages, packing as per the norm set | ASC/N6301
PC1, PC2, PC3, PC4, PC5, PC6, PC7, PC8, PC9, PC10, PC11, PC12, PC13, PC14, PC15, PC16, PC17, PC18, PC19 | Facilitator-led discussion
- Skill Practice (Activity) | Sample of Rejected parts for defects like dent, scratch, damage and burrs
- Packaging standards with visual aids | 5 hrs
8 hrs
8 hrs |
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Visual inspection of the part for scratches, dents, damages, packing as per the norm set</td>
<td>KB1, KB2, KB3, KB4, KB5, KB6, KB7, KB8, KB9, KB10 SA1, SA2, SA3, SA4, SA5, SA6, SA7, SA8 SB1, SB2, SB3, SB4, SB5, SB6, SB7, SB8, SB9, SB10, SB11, SB12, SB13, SB14, SB15, SB16, SB17</td>
</tr>
<tr>
<td></td>
<td>Conduct complete dimensional/layout inspection as per drawing</td>
<td>List of approved labs (NABL accredited) for outsourced testing</td>
</tr>
<tr>
<td></td>
<td>Conduct complete dimensional/layout inspection as per drawing</td>
<td>Stickers &amp; labels for ok, reject and Hold materials</td>
</tr>
<tr>
<td></td>
<td>Note down the observations of basic inspection process and identify ok &amp; not meeting specification parts a) Separate the defective parts into two categories 1. Parts which can be repaired/modified and pieces which are beyond repair. 2. Discard the pieces which are beyond repair and repair the pieces with minor defects, maintain record of each category.</td>
<td>Formats for dimensional, material &amp; function testing of parts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Min sample of 30 parts produced in one setting for conducting CP/CPK study (can be any category of parts)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operating manuals of precision instruments</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Personnel protection equipment- gloves, safety shoes, goggles, ear plugs, workshop safety, fire</td>
</tr>
</tbody>
</table>

**8 hrs**
• Note down the observations of basic inspection process and identify ok & not meeting specification parts
  a) Separate the defective parts into two categories
1. Parts which can be repaired/ modified and pieces which are beyond repair.
2. Discard the pieces which are beyond repair and repair the pieces with minor defects, maintain record of each category.
• Coordination with the respective process owners/seniors in QA and implement CAPA for discrepancies in the parameters identified in the report on immediate basis.

• Coordination with the respective process owners/seniors in QA and implement CAPA for discrepancies in the parameters identified in the report on immediate basis.

fextinguisher, first aid, safety signs, SOP chart on safety norms, charts of Do’s & don’t
• Handbooks & tech reference

8 hrs
<table>
<thead>
<tr>
<th></th>
<th>Participate in checking effectiveness of implementation and report the process till the discrepancies are resolved.</th>
<th>8 hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Participate in checking effectiveness of implementation and report the process till the discrepancies are resolved.</td>
<td>8 hrs</td>
</tr>
<tr>
<td></td>
<td>Document the observation of the inspection &amp; maintain records</td>
<td>2 hrs</td>
</tr>
<tr>
<td></td>
<td>Document the observation of the inspection &amp; maintain records</td>
<td></td>
</tr>
<tr>
<td>6. <strong>Maintain a safe and healthy working environment</strong></td>
<td>Maintaining health and safety at workplace, PPE, Safe working procedure, emergency procedure, hazards, first aid</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Identify activities which can cause potential injury through sharp objects, burns, fall, electricity, gas leakages, radiation, poisonous fumes, chemicals, loud noise</td>
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<tr>
<td></td>
<td>Create awareness amongst other by sharing information on the identified risks</td>
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</tr>
<tr>
<td></td>
<td>Operate the machine using the recommended Personal Protective Equipment (PPE)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ASC/N0006 PC1, PC2, PC3, PC4, PC5, PC6, PC7, PC8, PC9, PC10, PC11 KB1, KB2, KB3, KB4 SA1, SA2, SA3, SA4, SA5, SA6, SA7 SB1, SB2, SB3, SB4, SB5, SB6, SB7, SB8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Facilitator-led discussion</td>
<td></td>
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<tr>
<td></td>
<td>Skill Practice (Activity)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teaching Aids: Charts, CBTs, Videos, White board Markers, White board / Flip charts.</td>
<td>8 hrs</td>
</tr>
<tr>
<td></td>
<td>Personal Protection Equipment: Gloves, Safety Shoes, goggles, ear plugs,</td>
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<tr>
<td></td>
<td>Workshop Safety: Fire extinguishers</td>
<td></td>
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<tr>
<td></td>
<td>First Aid</td>
<td></td>
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<tr>
<td></td>
<td>Safety signs</td>
<td></td>
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<tr>
<td></td>
<td>SOP Charts on safety norms and drills</td>
<td>8 hrs</td>
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<tr>
<td></td>
<td><strong>Maintain a clean and safe working environment near the work place and ensure there is no spillage of chemicals, production waste, oil, solvents etc.</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Maintain high standards of personal hygiene at the work place</strong></td>
<td><strong>Charts of dos and Don’ts in work area.</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Ensure that the waste disposal is done in the designated area and manner as per organization SOP.</strong></td>
<td><strong>Standards, procedures and policies related to Health, Safety and Environment followed in companies</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Ensure that the waste disposal is done in the designated area and manner as per organization SOP.</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Charts of dos and Don’ts in work area.</strong></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td><strong>Maintain 5S at the work premises</strong></td>
<td><strong>Standards, procedures and policies related to Health, Safety and Environment followed in companies</strong></td>
</tr>
<tr>
<td></td>
<td><strong>5S safety system, waste management, waste management methods, storing and stacking of material</strong></td>
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<tr>
<td></td>
<td><strong>Follow the sorting process and check that the tools, fixtures &amp; jigs that are lying on workstations are the ones in use and un-necessary items are not cluttering the work benches or work surfaces.</strong></td>
<td><strong>Facilitator-led discussion</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Ensure segregation of waste in hazardous/ non Hazardous waste as per the sorting work instructions</strong></td>
<td><strong>Skill Practice (Activity)</strong></td>
</tr>
<tr>
<td></td>
<td>ASC/N0021 PC1, PC2, PC3, PC4, PC5, PC6, PC7, PC8, PC9, PC10, PC11, PC12, PC13, PC14, PC15, PC16, PC17, PC18, PC19, PC20, PC21, PC22, PC23, PC24, PC25, PC26 KB1, KB2, KB3, KB4, KB5, KB6, KB7, KB8, KB9, KB10, KB11, KB12, KB13, KB14</td>
<td><strong>Tools, fixtures &amp; jigs</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Facilitator-led discussion</strong></td>
<td><strong>Personal Protection Equipment:</strong> Gloves, Safety Shoes, goggles, ear plugs</td>
</tr>
<tr>
<td></td>
<td><strong>Skill Practice (Activity)</strong></td>
<td><strong>SOP document and charts on segregation and disposal of waste</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Tools, fixtures &amp; jigs</strong></td>
<td><strong>SOP on health safety and environment</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Personal Protection Equipment:</strong> Gloves, Safety Shoes, goggles, ear plugs</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>SOP document and charts on segregation and disposal of waste</strong></td>
<td></td>
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<td></td>
<td><strong>SOP on health safety and environment</strong></td>
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<tr>
<td></td>
<td>• Segregate the items which are labelled as red tag items for the process area and keep them in the correct places</td>
<td>SA1, SA2, SA3, SA4, SA5, SB1, SB2, SB3, SB4, SB5, SB6, SB7, SB8, SB9, SB10</td>
</tr>
<tr>
<td></td>
<td>• Properly stack the various types of boxes and containers as per the size/ utility to avoid any fall of items/ breakage and also enable easy sorting when required</td>
<td></td>
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<td></td>
<td>• Make sure that all material and tools are stored in the designated places and in the manner indicated in the 5S instructions</td>
<td></td>
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<td></td>
<td>• Ensure that the area has floors swept, machinery clean and generally clean. In case of cleaning, ensure that proper displays are maintained on the floor which indicate potential safety hazards</td>
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<td></td>
<td>8 hrs</td>
<td>8 hrs</td>
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</tr>
<tr>
<td>Task</td>
<td>Duration</td>
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<td>-----------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>• Ensure self-cleanliness - clean uniform, clean shoes, clean gloves, clean helmets, personal hygiene</td>
<td>8 hrs</td>
<td></td>
</tr>
<tr>
<td>• Participate actively in employee work groups on 5S and encourage team members for active participation</td>
<td>8 hrs</td>
<td></td>
</tr>
<tr>
<td>• Participate actively in employee work groups on 5S and encourage team members for active participation</td>
<td>1 hrs</td>
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</tbody>
</table>
Annexure II
Assessment Criteria

CRITERIA FOR ASSESSMENT OF TRAINEES

<table>
<thead>
<tr>
<th>Assessment Criteria for Fitter – Levelling, balancing and alignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job Role</td>
</tr>
<tr>
<td>Qualification Pack</td>
</tr>
<tr>
<td>Sector Skill Council</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Guidelines for Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Criteria for assessment for each Qualification Pack will be created by the Sector Skill Council. Each Performance Criteria (PC) will be assigned marks proportional to its importance in NOS. SSC will also lay down proportion of marks for Theory and Skills Practical for each PC.</td>
</tr>
<tr>
<td>2</td>
<td>The assessment for the theory part will be based on knowledge bank of questions created by the SSC.</td>
</tr>
<tr>
<td>3</td>
<td>Individual assessment agencies will create unique question papers for theory part for each candidate at each examination/training centre (as per assessment criteria below).</td>
</tr>
<tr>
<td>4</td>
<td>Individual assessment agencies will create unique evaluations for skill practical for every student at each examination/training canter based on this criteria.</td>
</tr>
<tr>
<td>5</td>
<td>To pass the Qualification Pack, every trainee should score a minimum of 70% in every NOS.</td>
</tr>
<tr>
<td>6</td>
<td>The marks are allocated PC wise; however, every NOS will carry a weight age in the total marks allocated to the specific QP.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assessment outcome (NOS Code and Description)</th>
<th>Assessment criteria (PC)</th>
<th>Total Marks</th>
<th>Out Of</th>
<th>Theory</th>
<th>Skills Practical</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASC/N3504 Assist in Carrying out pre-machining activities</td>
<td>PC1. understand the output product requirement by reading the engineering drawing specified in the work instructions/ work order</td>
<td>100</td>
<td></td>
<td></td>
<td>11</td>
</tr>
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<td></td>
<td>PC2. clearly understanding the does and don’ts of the manufacturing process as defined in SOPs/ Work Instructions or defined by supervisors</td>
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<td></td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>PC3. reading the control plan instructions/ job orders to determine the correct output product specifications</td>
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<td></td>
<td>10</td>
</tr>
<tr>
<td>PC4.</td>
<td>understanding the tooling instructions as specified in the Operating Manual/Work Instructions or Standard Operating Procedures</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PC5.</td>
<td>selection of proper coolant and lubricant required for machining the required component</td>
<td>11</td>
<td></td>
<td></td>
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<tr>
<td>PC6.</td>
<td>set the machine stops or guides as per the specified lengths indicated through scales or work instructions</td>
<td>10</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>PC7.</td>
<td>measure and mark reference points/ cutting lines on the work pieces, using compasses, calipers, rulers and other measuring tools</td>
<td>11</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

| PC1. | set-up, adjust machine tools in order to perform machining operations and keep dimension within the specified tolerance limit specified in the Standard Operating Procedures/Operating manuals | 7 |
| PC2. | support the operator in aligning and securely hold fixtures, cutting tools etc. onto the machine | 6 |
| PC3. | position/ secure/ align cutting tools in tool holders of the machine, using hand tools and verify their positions with measuring instruments | 6 |
| PC4. | start lathe or turning/drilling/milling machine for operations | 7 |
| PC5. | support in select cutting tools and tooling instructions as per the work instructions / supervisor’s instructions | 7 |
| PC6. | operate hand wheels or valves in order to feed the component and allow cooling and lubricating of the same as per the instructions given by the machinist/supervisor | 7 |
| PC7. | turn on the coolant valves and start their flow to maintain temperature in the lathe machine chamber | 7 |
| PC8. | move tool holders manually or by turning the hand wheels in order to feed tools along the machined component/ piece | 6 |

**ASC/N3505 Support the operator in performing machining operations**

| PC1. | Total | 100 |
| PC2. | | 6 |
| PC3. | | 6 |
| PC4. | | 7 |
| PC5. | | 7 |
| PC6. | | 7 |
| PC7. | | 7 |
| PC8. | | 6 |
PC9. observe machine operations to detect defects in the component manufactured

PC10. observe the machine operations for any malfunctions and immediately inform the supervisor of any malfunction observed to prevent damage to the machining equipment/ output product

PC11. support the operator in recording operational data such as pressure readings, length of strokes, feed rates, speed etc in the formats specified by the supervisors

All KA, KB for the NOS

<table>
<thead>
<tr>
<th>ASC/N3506</th>
<th>Support the operator in conducting all post machining operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC1.</td>
<td>maintain the machine as per proper operational condition</td>
</tr>
<tr>
<td>PC2.</td>
<td>perform minor machine maintenance activities such as oiling or cleaning machine and its components</td>
</tr>
<tr>
<td>PC3.</td>
<td>oiling or cleaning machines as per the schedules given in the maintenance plan</td>
</tr>
<tr>
<td>PC4.</td>
<td>adding coolant and lubricant in machine reservoir</td>
</tr>
<tr>
<td>PC5.</td>
<td>with the help of the correct tool remove the extra burrs, sharp edges, rust and chips from the metal surface</td>
</tr>
<tr>
<td>PC6.</td>
<td>use files, hand grinders, wire brushes, or power tools for performing de-burring operations. Ensure usage of Personal Protective equipment like eye glasses and hand gloves.</td>
</tr>
<tr>
<td>PC7.</td>
<td>for automated processes perform shot blasting/ vibro processes for completing de-burring operations</td>
</tr>
<tr>
<td>PC8.</td>
<td>support the operator in measuring the specifications of the finished component and verify conformance as per CP/ WI</td>
</tr>
<tr>
<td>PC9.</td>
<td>use devices like micrometers, vernier calipers, gauges, rulers and any other inspection equipment for measuring specifications with valid calibration status</td>
</tr>
<tr>
<td>PC10. support the operator in noting down the observations of the basic inspection process and identify pieces which comply with the specified standards</td>
<td></td>
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<td>---</td>
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</tr>
<tr>
<td>PC11. separate the defective pieces into two categories – pieces which can be repaired/ modified and pieces which are beyond repair and maintain records of each category</td>
<td></td>
</tr>
<tr>
<td>PC12. assist the operator in changing different worn machine accessories, such as cutting tools (as per tool life listed, recommended) and brushes, other hand tools</td>
<td></td>
</tr>
<tr>
<td>PC13. replace machine part as per work instructions, using hand tools or notify supervisor/ engineering personnel for taking corrective actions</td>
<td></td>
</tr>
<tr>
<td>PC14. for automated process observe the tool change cycle in order to ensure that the selected tool is transferred to the spindle from magazine after the previous tool is transferred to the magazine from the spindle</td>
<td></td>
</tr>
<tr>
<td><strong>All KA, KB for the NOS</strong></td>
<td><strong>Total</strong></td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>ASC/N6301 Inspect and maintain the product quality</th>
<th></th>
<th>4</th>
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<tbody>
<tr>
<td>PC1. conduct the process of inspection at the stages</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>PC2. handle Inspection equipment and Instruments</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>PC3. conduct a inspection of the product covering the following checkpoints</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>PC4. coordinate with the respective process owners/ seniors in QA and implement CAPA for discrepancies in the parameters identified in the report on immediate basis</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>PC5. participate in checking the effectiveness of implementation and repeat the process till the discrepancies are resolved</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>PC6. document the observations of the inspection and maintain records of</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>PC7. IR, ERP-System record and special process capability index calculation/charting as per the SOP</td>
<td>raise a scrap note and dispose off the scrapped product in the scrap yard as per the defined procedure maintaining the HSE compliance</td>
<td>5</td>
</tr>
<tr>
<td>PC8. As is the case i.e. New product/process development/Production phase, the reports and Part Submission Warrant, PPAP are to be prepared.</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>PC9. based on the implementation of information flow system in organization like ERP/SAP, upload the reports</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>PC10. conduct a dock audit of a sample batch from the production lot of the ready to dispatch final products covering the following checkpoints</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>PC11. coordinate with the respective process owners/Stores and implement CAPA for discrepancies identified in the dock audit on immediate basis</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>PC12. review the effectiveness of implementation and repeat the process till the discrepancies are resolved</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>PC13. document the observations of dock audit and maintain records</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>PC14. based on the implementation of information flow system in organization like ERP/SAP, upload the reports</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>PC15. work as a CFT member of the team formed for solving a problem pertaining to the products handled. Collect data regarding the problem as decided in the team discussions</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>PC16. participate for preparation of Fault tree, conducting simulation and implementation of actions</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>PC17. participate for updating relevant documentation</td>
<td>4</td>
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</tr>
<tr>
<td>PC18.</td>
<td>assist the NPD department in efficient development of the new product by sharing all the problems related to QCD observed in the existing products</td>
<td></td>
</tr>
<tr>
<td>All KA, KB for the NOS</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>25</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ASC/N0006</th>
<th>Maintain a safe and healthy working environment</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PC1.</td>
<td>identify activities which can cause potential injury through sharp objects, burns, fall, electricity, gas leakages, radiation, poisonous fumes, chemicals, loud noise</td>
<td>100</td>
<td>7</td>
</tr>
<tr>
<td>PC2.</td>
<td>inform the concerned authorities about the potential risks identified in the processes, workplace area/layout, materials used etc</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>PC3.</td>
<td>inform the concerned authorities about damages which can potentially harm man/machine during operations</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>PC4.</td>
<td>create awareness amongst other by sharing information on the identified risks</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>PC5.</td>
<td>follow the instructions given on the equipment manual describing the operating process of the equipments</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>PC6.</td>
<td>follow the Safety, Health and Environment related practices developed by the organization</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>PC7.</td>
<td>operate the machine using the recommended Personal Protective Equipments (PPE)</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>PC8.</td>
<td>maintain a clean and safe working environment near the workplace and ensure there is no spillage of chemicals, production waste, oil, solvents etc</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>PC9.</td>
<td>maintain high standards of personal hygiene at the workplace</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>PC10.</td>
<td>ensure that the waste disposal takes place in the designated area as per organization SOP</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>PC11.</td>
<td>inform appropriately the medical officer/HR in case of self or an employee’s illness of contagious nature so that preventive actions can be planned for others</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>All KA, KB for the NOS</td>
<td></td>
<td>30</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>30</strong></td>
<td><strong>70</strong></td>
</tr>
<tr>
<td>PC1.</td>
<td>follow the sorting process and check that the tools, fixtures &amp; jigs that are lying on workstations are the ones in use and un-necessary items are not cluttering the workbenches or work surfaces</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td>PC2.</td>
<td>ensure segregation of waste in hazardous/ non Hazardous waste as per the sorting work instructions</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>PC3.</td>
<td>follow the technique of waste disposal and waste storage in the proper bins as per SOP</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>PC4.</td>
<td>segregate the items which are labeled as red tag items for the process area and keep them in the correct places</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>PC5.</td>
<td>sort the tools/ equipment/ fasteners/ spare parts as per specifications/ utility into proper trays, cabinets, lockers as mentioned in the 5S guidelines/ work instructions</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>PC6.</td>
<td>ensure that areas of material storage areas are not overflowing</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>PC7.</td>
<td>properly stack the various types of boxes and containers as per the size/ utility to avoid any fall of items/ breakage and also enable easy sorting when required</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>PC8.</td>
<td>return the extra material and tools to the designated sections and make sure that no additional material/ tool is lying near the work area</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>PC9.</td>
<td>follow the floor markings/ area markings used for demarcating the various sections in the plant as per the prescribed instructions and standards</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>PC10.</td>
<td>follow the proper labeling mechanism of instruments/ boxes/ containers and maintaining reference files/ documents with the codes and the lists</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>PC11.</td>
<td>check that the items in the respective areas have been identified as broken or damaged</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>PC12.</td>
<td>follow the given instructions and check for labeling of fluids, oils, lubricants, solvents, chemicals etc. and proper storage of the same to avoid spillage, leakage, fire etc.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>PC13.</td>
<td>make sure that all material and tools are stored in the designated places and in the manner indicated in the 5S instructions</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>PC14.</td>
<td>check whether safety glasses are clean and in good condition</td>
<td>2</td>
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</tr>
<tr>
<td>PC15.</td>
<td>keep all outside surfaces of recycling containers are clean</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>PC16.</td>
<td>ensure that the area has floors swept, machinery clean and generally clean. In case of cleaning, ensure that proper displays are maintained on the floor which indicate potential safety hazards</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>PC17.</td>
<td>check whether all hoses, cabling &amp; wires are clean, in good condition and clamped to avoid any mishap or mix up</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>PC18.</td>
<td>ensure workbenches and work surfaces are clean and in good condition</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>PC19.</td>
<td>follow the cleaning schedule for the lighting system to ensure proper illumination</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>PC20.</td>
<td>store the cleaning material and equipment in the correct location and in good condition</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>PC21.</td>
<td>ensure self-cleanliness - clean uniform, clean shoes, clean gloves, clean helmets, personal hygiene</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>PC22.</td>
<td>follow the daily cleaning standards and schedules to create a clean working environment</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>PC23.</td>
<td>attend all training programs for employees on 5S</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>PC24.</td>
<td>support the team during the audit of 5S</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>PC25.</td>
<td>participate actively in employee work groups on 5S and encourage team members for active participation</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>
PC26. follow the guidelines for What to do and What not to do to build sustainability in 5S as mentioned in the 5S check lists/ work instructions

<table>
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</table>

Do

- Explain each Guideline for Assessment in detail
- Explain the score that each trainee needs to obtain
- Recapitulate each NOS one-by-one and take participants through the allocation of marks for Theory and Skills Practical.
- Explain the Allocation of Marks. Explain that they will be assessed on Theory and Skills Practical.
- Explain that for the first NOS, 25 marks are allotted for Theory and & 75 for Skills Practical.

Notes