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# PROJECT PLANNING, DESIGN AND IMPLEMENTATION (AALL10)

## 10.1 ENGINEERING DRAWINGS AND ITS CONCEPTS

### Engineering drawings and its concepts

**Engineering Drawing:** An engineering drawing is a type of technical drawing that is used to convey information about an object.

- Engineering drawing depicts the essential features of the drawn/ engineered objects. Essential features like: material, shape, size, quality of surface, manufacturing process etc.
- Engineering drawing can also be considered as a graphic language through which an engineer visualizes the object.

Some of the standards of drawings are:

- o Bureau of Indian Standards (BIS)
- o DIN of Germany
- o BS of Britain
- o ANSI of America

### Application of Engineering Drawing:

- Building drawing → Civil engineers,
- Machine drawing → Mechanical engineers,
- Circuit diagrams → Electrical and electronics engineers,
- Computer graphics → Computer Engineers as well as for all.

### Instruments and Aids used in Engineering Drawing:

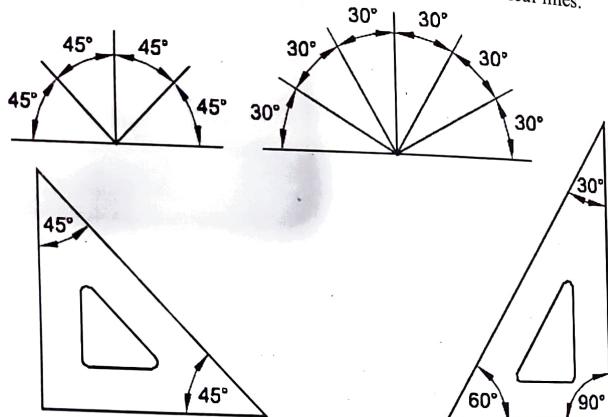
- |                   |                   |
|-------------------|-------------------|
| 1. Drawing Sheets | 2. Drawing Board  |
| 3. Set squares    | 4. French curves  |
| 5. Templates      | 6. Mini daughter  |
| 7. Protractor     | 8. Instrument Box |
| 9. Set of scales  | 10. Pencils       |

- 1. Drawing Sheets:** The standard drawing sheet sizes are arrived at on the basic principle of  $x:y = 1$ :  $\sqrt{2}$  and  $xy = 1$  where 'x' and 'y' are the sides of the sheet.
- Table 1.1*

Designation	Dimension
A0	841 × 1189 mm
A1	594 × 841 mm
A2	420 × 594 mm
A3	297 × 420 mm
A4	210 × 297 mm
A5	148 × 210 mm

For example AO, having a surface area of 1 Sq.m;  $x = 841$  mm and  $y = 1189$  mm. The successive sizes are obtained by either by halving along the length or doubling the width, the area being in the ratio 1 : 2.

- 2. Drawing Board:** The drawing boards used to draw an object is made up of softwood of thickness about 25 mm. Drawing sheet is placed at the top of the drawing board to draw an object.
- 3. Set Squares:** Set squares are the engineering drawing instruments, which are triangular in nature, often used with T-squares for drawing inclined or vertical lines.

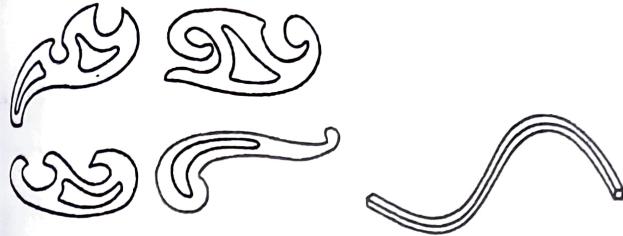


**(a) 45° SET SQUARE**

**(b) 30° - 60° SET SQUARE**

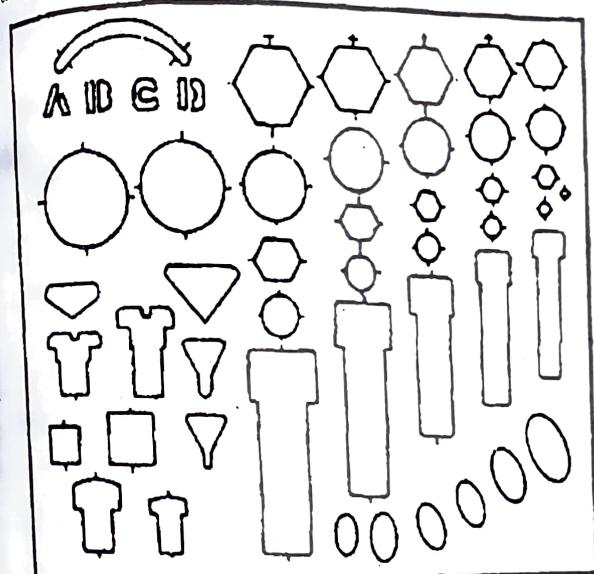
*Figure: Set square*

- 4. French curves:** A soft plastic, metal or wooden material used to draw smooth curves/ arcs. A flexible curve is made up of flexible lead/ steel bar coated with rubber at outer layer so that bends quickly and can draw smooth curve/ arcs.



*Figure: French curve and Flexible curve*

**Templates:** Templates are aids and are useful for drawing many features of the object. Features like, small circles, squares, rectangles, triangles, polygons etc.



*Figure: Templates*

**Mini-draughters:** A mini-draighter or drafter consists two adjustable arms in which two scale set are perpendicularly connected to each other and is attached at lower arm end. Mini-drafter used for drawing following elements:

- Horizontal lines
- Vertical lines
- Inclined lines
- Angles
- Parallel lines
- Perpendicular lines

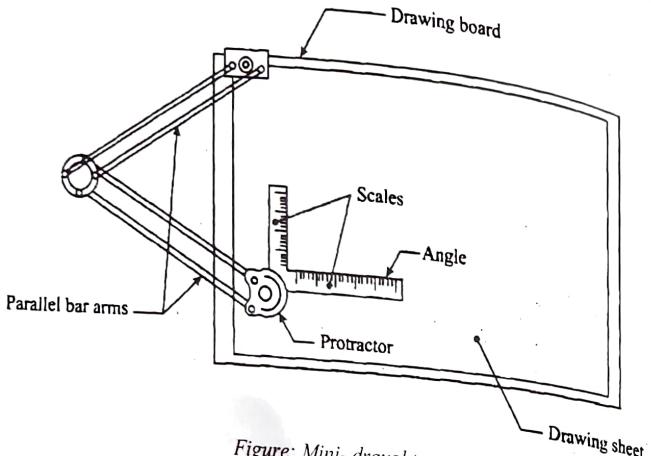


Figure: Mini-draughtsman

7. **Protractor:** Protractor is an instrument which is either circular or semi-circular that is used for measuring an angle.
8. **Instrument box:** A box in which compass, divider and inking pens are kept.
9. **Set of scales:** During drawing of an image, whenever it's required to proportionate the desired size of an object, we use scale. Scales can be made up of plastics, steels and woods. Bureau of Indian Standard (BIS) recommends eight different set of scales naming M1, M2, ..., M8.

Table: Set of scales

	M1	M2	M3	M4	M5	M6	M7	M8
Scale on edge	1:1	1:2.5	1:10	1:50	1:200	1:300	1:400	1:1000
Scale on other edge	1:2	1:5	1:20	1:100	1:500	1:600	1:800	1:2000

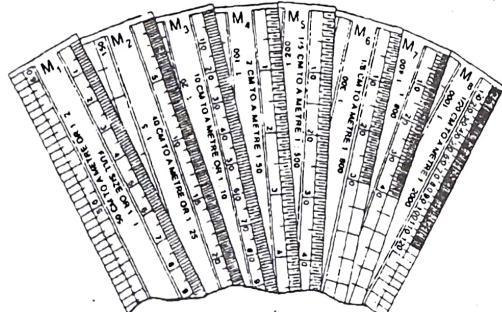


Figure: Set of scales

Do not use the scales as a straight edge for drawing straight lines. These are used for drawing irregular curved lines, other than circles or arcs of circles.

Table: Scale categories

Category	Recommended scales		
	50:1	20:1	10:1
Large scale	5:1	2:1	
Medium scale	1:1		
Small scale	1:2	1:5	1:10
Reduction scales	1:20	1:50	1:100
	1:200	1:500	1:1000
	1:2000	1:5000	1:10000

Pencils: Pencils that can be used for drawing objects can be found with different degrees of hardness: 3H, 2H, H, HB, B, 2B, 3B etc. these represents the types of pencils with the level of hardness and softness of the leads.

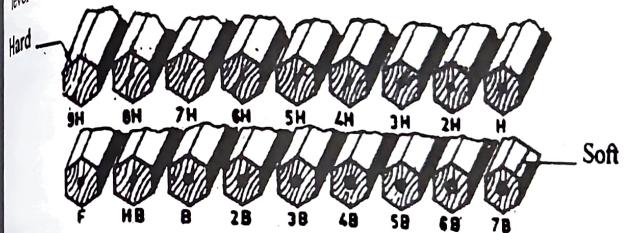


Figure: Pencil leads

H → Hard; depicts hardness

B → Black; depicts softness

F → Fine point

For sharp black line use H or 2H

For borderline, free sketching, lettering and dimensioning use HB (Soft grade)

For visible outlines, visible edges and boundary lines use H (Medium grade)

For construction lines, Dimension lines, Leader lines, Extension lines, Centre lines, Hatching lines and Hidden lines use 2H (Hard grade)

#### Dimensioning and Dimension

**Title Block:** At the bottom right-hand corner of the sheet, the title block is made and the title is written. The maximum length for the title block is 170mm. Title block provides following information:

- Title of the drawing

- Drawing number
  - Symbol denoting method of projection
  - Scale
  - Name of the firm
  - Initials of staff who have designed, checked and approved
- 2. Folding of Drawing Sheets:** IS: 11664 - 1999 suggests two methods for folding of the drawing sheets.
- Folding of drawing sheet for filing or binding.
  - Folding of drawing sheet for storing in filing cabinet.
- 3. Lines (IS 10714 (part 20): 2001 and SP 46: 2003):** Different types of lines are drawn in drawing to depict the details of various objects. According to IS 10714 (Part 20): 2001 (General principles of presentation on technical drawings) and SP 46:2003 there are following types of lines:
- Visible Outlines, Visible Edges: Continuous wide lines; Type 01.2 → represents the visible outlines/ visible edges / surface boundary lines of objects.
  - Dimension Lines: Continuous narrow lines; Type 01.1 → used for marking dimension.
  - Extension Lines: Continuous narrow lines; Type 01.1
  - Construction Lines: Continuous narrow lines; Type 01.1 → used for constructing drawings and should not be erased after completion of the drawing.
  - Hatching / Section Lines: Continuous narrow lines; Type 01.1 → used for drawing sectioned portion of an object.
  - Guide Lines: Continuous narrow lines; Type 01.1 → used for drawing purpose.
  - Break Lines: Continuous narrow freehand lines; Type 01.1 → used for representing break of an object.
  - Break Lines: Continuous Narrow Lines with Zigzags; Type 01.1 → used for representing break of an object.
  - Dashed Narrow Lines: Dashed Narrow Lines; Type 02.1 → used for representing hidden edges / hidden outlines of objects are shown by dashed lines of short dashes of equal lengths of about 3 mm, spaced at equal distances of about 1 mm.
  - Center Lines: Long-Dashed Dotted Narrow Lines; Type 04.1 → drawn at the center of the drawings symmetrical about an axis or both the axes.
  - Cutting Plane Lines: Type 04.1 and Type 04.2 → drawn to show the location of a cutting plane.
  - Border Lines: Has minimum thickness 0.7 mm and are continuous wide lines.

### Dimensioning

- Dimension is the numerical value that defines the size or geometric characteristic of a feature. It is indicated graphically in a proper unit of measurement on engineering drawing with lines, symbols, and notes.

**basis dimension** is the numerical value defining the theoretically exact size of a feature.  
**reference dimension** is the numerical value enclosed in parentheses provided for information only and is not used in the fabrication of the part.

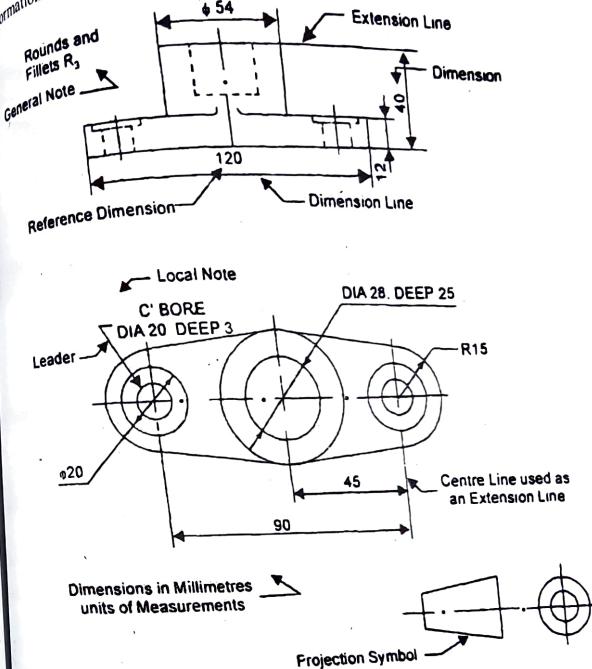


Figure: Elements of dimensioning

### Types of Dimensioning:

- **Functional dimensions (F):** Essential to the function of the piece or space.
- **Non-functional dimensions (NF):** Not essential to the function of the piece or space.
- **Auxiliary dimensions (AUX):** Given for information purpose only.

### Dimension Terminologies:

- **Dimension value:** Numeric value assigned to the size, shape, or location of the object that has been drawn. Dimension values needs to be written at the middle of the dimension lines.
- **Dimension lines:** Thin continuous lines that are placed 8mm to 10mm away from the outline of the drawing and placed 6mm to 8mm apart from each other.

- Projection lines:** Thin continuous lines that are stretched out from the outlines for dimensioning and extended 2mm to 3mm beyond the dimension lines.
- Leaders:** Thin continuous lines and terminated by an arrowhead or dot referring to a feature and note
- Arrowheads:** Dimension lines are ended or terminated by using arrow heads. The arrowheads may be open at a convenient angle of 30° to 90°, closed filled, or close blank.  
Length of arrow head (in case of small drawing) → 3mm  
Length of arrow head (in case of large drawing) → 5mm

#### Principles of Dimensioning

- Dimension information that describes clear and complete component should be written directly on drawing.
- During a dimensioning of features, one-time dimensioning of each feature is accepted.
- If the object has a best view, then the dimension should be written on that best view.
- If possible express dimension in only one unit i.e., millimeter but without writing (mm)
- If possible, always place the dimension outside the view.
- Take dimensions from visible outlines rather than from hidden lines.
- Between the feature and the start of the extension line, there should not be any gap.
- Long dash should be used for crossing of the center lines not a short dash.

#### Dimension indicating methods

- Method 1 → Aligned Method:** Place the dimensions parallel to and above their dimension lines and preferably at the middle, and clear of the line.
- Method – 2 → Unidirectional method:** Indicate the dimension so that they can be read from the bottom of the drawing only.

**Arrangement of Dimension:** Arranged in 3 ways.

- Chain dimensioning:** Chain of single dimensioning should be used only where the possible accumulation of tolerances does not endanger the fundamental requirement of the component.

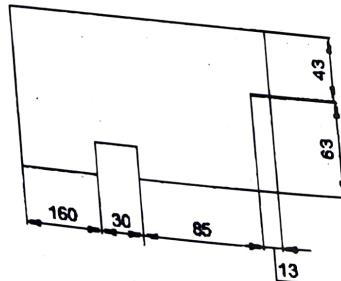


Figure: Chain Dimensioning

**Parallel dimensioning:** If a number of dimensions have a common datum feature, then parallel dimensioning can be used. In this kind of dimensioning a number of dimension lines parallel to one another and spaced out, are used.

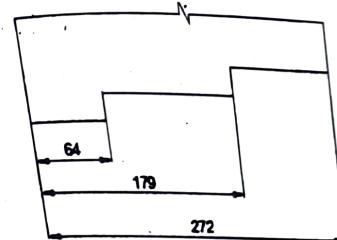


Figure: Parallel dimensioning

**Combined dimensioning:** Simultaneous use of parallel dimensioning, chain dimensioning, and running dimensioning in a single drawing.

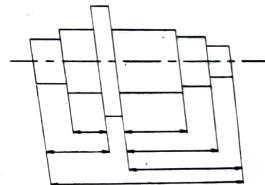


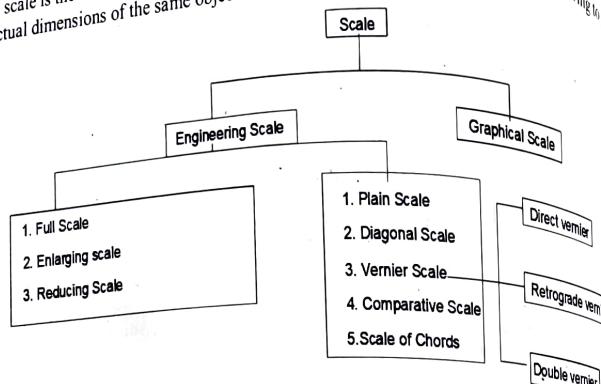
Figure: Combined dimensioning

Some important points on dimensioning suggested by "K. Venkata Reddy, Textbook of Engineering Drawing"

- Dimension should follow the shape symbol.
- If possible do not use features as extension lines for dimensioning.
- Extension line should touch the feature.
- Extension line should project beyond the dimension line.
- Writing the dimension is not as per aligned method.
- Hidden lines should meet without a gap.
- Horizontal dimension line should not be broken to insert the value of dimension in both aligned and uni-direction methods.
- Dimension should be placed above the dimension line.
- Radius symbol should precede the dimension.
- Centre line should cross with long dashes not short dashes.
- Dimension should be written by symbol followed by its values and not abbreviation.
- Note with dimensions should be written in capitals.

### Scale:

A scale is the ratio of the linear dimension of an object's element as shown in a drawing to the actual dimensions of the same object's element.



**Reducing and enlarging scale:** Those natural objects that are originally big in size are cannot be represented in full size drawing in paper. In such case we use reducing scales to reduce the actual size of object and construct it on drawing sheet. Similarly in case of small objects like small electronic parts of watches, mobile phones, diodes, capacitors, transistors etc. drawing full size image may not represent the object clearly. So, we need to enlarge the scale.

- **Full-size scale:** If the actual size of object is drawn on the drawing sheet, then the scale used is known as full-size scale. Example: A 40 mm radius plain disc is represented on the drawing by a circle of 40 mm radius.

Scale Ratio 1:1 → Full-size scale

- **Enlarging scale:** Drawing a small components like diode, transistors on a drawing sheet to view it in big size for higher accuracy and to represent smaller object clearly.

Scale Ratio > 1:1 → Enlarging scale

- **Reducing scale:** Object having large dimension like, vehicles, machinery parts, building etc. in smaller size so that the construction fits into drawing sheet.

Scale Ratio < 1:1 → Reducing scale

#### **Note:**

- Scale 1:1 for full size scale
- Scale 1:x for reducing scales ( $x = 50, 100, \dots$  etc.,)
- Scale x:1 for enlarging scales.

#### **BIS recommends scales in Engineering Drawing:**

- Full Scales- 1:1
- Reducing Scales - 1:2, 1:5, 1:10, 1:50, 1:100, 1:200, 1:1000, 1:2000, 1:5000
- Enlarging Scales- 50:1, 20:1, 10:1, 5:1, 2:1.

### Metric Measurements

- 10 millimetres (mm) = 1 centimetre(cm)
- 10 centimetres (cm) = 1 decimetre(dm)
- 10 decimetre (dm) = 1 metre(m)
- 10 metres (m) = 1 decametre (dam)
- 10 decametre (dam) = 1 hectometre (hm)
- 10 hectometres (hm) = 1 kilometre (km)
- 1 hectare = 10,000 m<sup>2</sup>

**Representative Fraction:** The ratio of the dimension of the object shown on the drawing to its actual size is called the Representative Fraction (RF).

$$RF = \frac{\text{Drawing size of an object}}{\text{Its actual size}} \text{ (in same units)}$$

- RF for full-sized scale = 1
- RF for reducing scale < 1
- RF for enlarging scale > 1

For example, if an actual length of 6 meters of an object is represented by a line of 30mm length on the drawing.

$$RF = 30\text{mm} / 6\text{m} \rightarrow 30\text{mm} / (6 \times 1000) \text{ mm} \rightarrow 1/200 \text{ or } 1:200$$

### **Types of Scale**

- **Plane Scale:** A line that is divided into specific number of equal pieces/parts. the first of which has been further subdivided into smaller portions. Plane scale is used to measure up to two consecutive units i.e., a unit, or a fraction of unit, such as km and hm, m and dm, cm and mm etc.
- **Diagonal Scale:** A diagonal scale is used when the measurements are required in three consecutive units i.e., a unit and its immediate two subdivisions, such as metres, decimetres, centimetres or to read to the accuracy correct to two decimals.
- **Comparative Scale:** A comparison scale is a pair of scales with the same representative fraction but graduated to read measurements in several unit systems. Depending on the situation, comparative scales can be built as plain or diagonal scales.
- **Vernier Scale:** Used to measure three consecutive units of a metric scale. Hence, the accuracy in measurement of the vernier scale is equivalent to that of a diagonal scale. The vernier scales in engineering drawing is used to indicate the distances in a unit and its two immediate subdivisions. Vernier Scale has 2 parts: i) main scale and ii) vernier scale

- **Forward vernier scale or direct vernier scale:**

- The smallest division of the main scale ( $x$ ) > The smallest division of the vernier scale ( $y$ ).
- The least Count of the direct vernier; ( $x-y$ )

- Backward vernier scale or retrograde vernier scale:**
  - The smallest division of the main scale ( $x$ ) < The smallest division of the vernier scale ( $y$ ).
  - The least Count of the direct vernier; ( $y-x$ )
- Double vernier scale:** In the double vernier, two simple verniers are placed end to end to form a single scale with zero at the center. One vernier is used for taking readings in the clockwise direction and the other vernier is used for taking readings in the anti-clockwise direction.

### Projections:

#### Types of Projections

- Pictorial projections:** In one view the description of the object is clearly understood.
  - Perspective projection
  - Isometric projection
  - Oblique projection
- Orthographic Projections/ Multiview Projections:** Also known as orthogonal projection is a process of representing three-dimensional objects in two dimensions. Orthographic Projections is a technical drawing in which different views of an object are projected on different reference planes observing perpendicular to respective reference plane.

Reference planes are:

- Horizontal Plane (HP)
- Vertical Plane (VP)
- Side or Profile Plane (PP)

Views are:

- Front View (FV) – Projected on VP
- Top View (TV) – Projected on HP
- Side View (SV) – Projected on PP

#### Applications of Orthographic Projections:

- Selection of views
- Simple solids
- Three view drawing
- Development of missing drawings

#### Important Points on Reference planes and Views:

- Top view of an object is shown on → Horizontal Plane
- Side view of an object is shown on → Profile Plane
- Front view of an object shown on → Vertical Plane
- To represent the object on paper by orthographic projection → Turn Horizontal plane in a clockwise direction up to 90 degrees.
- Regular cone is rested on base on horizontal plane → Front view will be Isosceles triangle.

- Cube is placed on a horizontal plane such that one of the space diagonals is perpendicular to the horizontal plane → Top view will be Hexagon.
- Cylinder's axis is perpendicular to profile plane → Top view will be Rectangle.
- Egg is placed vertical to horizontal plane → Top view will be Circle.
- Plate of a negligible thickness of circular shape is placed parallel to horizontal plane → Front view will be Line.
- Regular tetrahedron is placed on a horizontal plane on one of its base → Front view. Top view, Side view gives Triangle.
- Regular cone is placed on horizontal plane on its base → Top view is Circle.
- Square pyramid is resting on a vertical plane with the base parallel to the vertical plane → Side view will be Triangle.
- Triangular prism is placed in a projection plane such that the square surface is parallel to the horizontal plane → Top view, Front view will be Rectangle, Rectangle respectively.
- Pentagonal prism is placed such that its axis is perpendicular to horizontal plane → Top view and Front view are Pentagon, Rectangle respectively.
- Hexagonal nut is placed on a horizontal plane such that the axis is perpendicular to the profile plane → Top view and Side view will be Rectangle, Hexagon respectively.

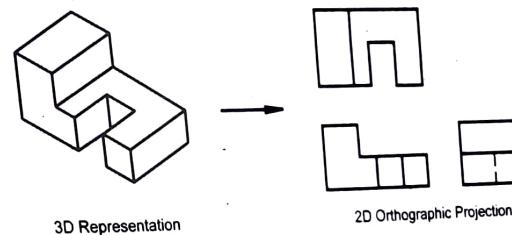


Figure: Orthographic Projection

#### Six principal views of an orthographic projection:

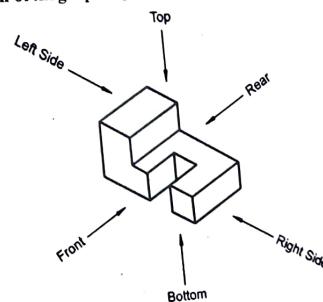


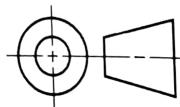
Figure: Six principal views

### **Line types used in orthographic projections:**

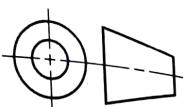
1. Visible lines
2. Hidden lines
3. Center lines
4. Phantom lines
5. Dimension and Extension lines
6. Section lines
7. Cutting plane lines
8. Break lines

### **Projection systems:**

- 1) 1<sup>st</sup> Angle Projection
- 2) 3<sup>rd</sup> Angle Projection



Third Angle Projection Symbol



First Angle Projection Symbol

Figure: Projection Symbols

### **First Angle Projection:**

- Preferred in European Countries
- ISO Standard
- The object is imagined to be in 1<sup>st</sup> quadrant
- Between observer and plane of projection, the object lies
- Assume Plane of projection to be non-transparent

### **Third Angle Projection:**

- Preferred in USA, Canada, Thailand, Japan
- The object is imagined to be in 3<sup>rd</sup> quadrant
- Between observer and object, the plane of projection lies
- Assume plane of projection to be transparent

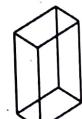
### **Isometric Projections:**

An isometric projection is one type of pictorial projection in which the three dimensions of a solid are not only shown in one view, but also their dimension can be scaled from this drawing.

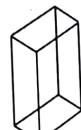
- **Isometric View:** Drawn to actual scale.
- **Isometric Projection:** Drawn to isometric scale.



ORTHOGRAPHIC PROJECTION



ISOMETRIC PROJECTION



ISOMETRIC VIEW

Figure: Orthographic projection vs Isometric projection vs Isometric view

Isometric view/ drawing of figure is slightly larger (approximately 22%) than the original projection.

### **Isometric Projection**

Line parallel on the object → Parallel in the isometric projection.

Vertical lines on the object → Vertical in the isometric projection.

Horizontal lines on the object are drawn at an angle of 30° with the horizontal in the isometric projection.

Line parallel to an isometric axis → Isometric line which is foreshortened to 82%.

Line not parallel to any isometric axis → non-isometric line.

### **Methods of Constructing Isometric Drawing:**

**Box method:** If an object contains a number of non-isometric lines, the isometric drawing may be conveniently constructed by using the box method.

**Offset method:** If the object contains irregular curved surfaces, then the offset method is preferred.

### **Important points on Isometric Drawing:**

Isometric view of equilateral triangle → Scalene Triangle

Isometric view of isosceles triangle → Scalene Triangle

Isometric view of right angled triangle → Scalene Triangle

Isometric view of rhombus → Parallelogram

Isometric view of rectangle → Parallelogram

### **Perspective projection:**

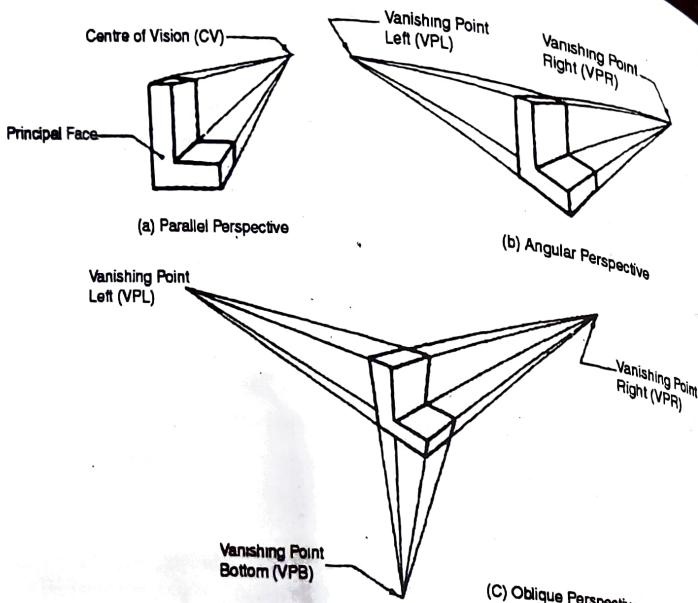
Object's graphic representation on a single plane i.e., picture plane as seen by a viewer situated at a particular position relative to the object. Viewer is stationed in front of the picture plane and the object is placed behind the picture plane, here picture plane cuts the visual rays from viewer's eyes to the object. This type of projection is called perspective projection.

### **Classification of Perspective projection:**

**Parallel perspective or single point perspective:** If the principal face of the object viewed, is parallel to the picture plane, the perspective view formed is called parallel perspective.

**Angular perspective or two-point perspective:** If the two principal faces of the object viewed are inclined to the picture plane, the perspective view formed is called angular perspective.

**Oblique perspective or three-point perspective:** If all the three mutually perpendicular principal faces of the object viewed, are inclined to the picture plane, the perspective view formed is called oblique perspective.



*Figure: Classification of perspective projection*

#### Methods of Perspective projection:

- **Visual ray method:** Points on the perspective projection are obtained by drawing visual rays from station point to both top view and either front view or side view of the object. Top and side views are drawn in Third Angle Projection.
- **Vanishing point method:** It is an imaginary point infinite distance away from the station point. The point at which the visual ray from the eye to that infinitely distant vanishing point pierces the picture plane is termed as the Vanishing Point.

#### Oblique projection:

Projecting the object with parallel projections that are oblique to the picture plane by this technique we obtain the oblique projection of any object.

#### Advantages of oblique projection over isometric drawing:

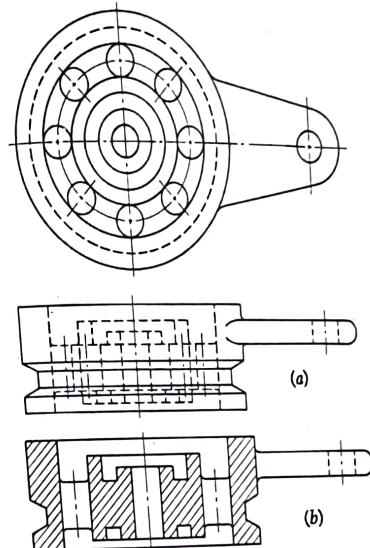
- Circular or irregular features on the front face appear in their true shape.
- Distortion may be reduced by fore-shortening the measurement along the receding axis.
- A greater choice is permitted in the selection of the position of the axes.

#### Classification of Oblique projection:

- **Cavalier Oblique Drawing:** One axis is horizontal, and the other is vertical while the third axis is at  $45^\circ$  to the horizontal line.

**Cabinet Oblique Drawing:** One axis is horizontal, and the other is vertical while the third axis is from  $30^\circ$  to  $60^\circ$  to the horizontal line. Such drawing resembles much with the actual image.

**Sectional Drawing:** Interior details of objects are complicated so sections are used to show interior details of an object clearly. Interior details of an objects are shown by hidden lines in usual orthographic views, makes difficult to understand the drawing which is shown in figure (a).



*Figure: Sectional view*

In order to reveal the interior features/ details of an object clearly, one or more than one views are drawn as if some portion has been cut away which is shown in figure (b). This technique is called sectioning. The view that depicts the cut away picture is section view.

#### Importance of section views:

- Visualization and clarity of new designs are improved.
- Depicts Multiview drawings.
- Depicts the interior features of an object parts
- Dimensioning of drawings are facilitated.

**Cutting Planes:** To obtain clear sectional views several cutting planes can be selected. Cutting plane is a plane that imaginarily cuts the objects to depict the internal details. Depending on the several numbers of cutting planes, the sectional views can be complex with two or more cutting planes and simple with only one cutting plane.

#### Types of Sections:

- **Full section:** Cutting plane line cuts entirely across the object.
- **Offset section:** Pass the bended cutting plane completely through the part.
- **Half section:** Cutting plane cuts halfway through the part.
- **Broken-out section:** Shows only an interior portion of the object in section.
- **Rotated section:** To show section some object parts have to be rotated. Cutting plane is passed perpendicular to the axis of the part to be cut, revolve cut portion to 90 degree and draw in this position (turn the section until it is parallel with the plane of projection)
- **Removed section:** It is a revolved section drawn outside of the normal view.

#### Important points on sectional drawing:

- Drafter has several choices of section techniques to reveal an internal feature of an object.
- Object having a symmetry, an appropriate choice is such as full section or half section.
- Object having several features that do not locate in-line among each other, an offset section may be a good choice.
- Broken-out section is usually used when a drafter needs to reveal a local detail of each feature.
- Revolved and removed section views are efficient when a drafter needs to reveal only a cross section shape of an object.

## 10.2 ENGINEERING ECONOMICS

### Economics

A social science known as economics focuses on the study of how products and services are produced, distributed, exchanged, and consumed.

There are two main branches of economics: microeconomics and macroeconomics

- Microeconomics is concerned with the behavior and decision-making of individual economic agents, such as consumers and firms, and how they interact in markets.
- Macroeconomics examines the functioning and behavior of the economy as a whole, covering issues like inflation, unemployment, and economic expansion.

The father of economics is widely considered to be Adam Smith, a Scottish philosopher and economist who lived from 1723 to 1790. Smith's support of laissez-faire economics, a theory that emphasizes the market's role in determining pricing, production, and distribution of goods and services, is his main contribution to economics.

### Engineering Economics

Engineering Economics is a subfield of economics that focuses on using economic theories and methodologies to assess and plan engineering projects. It involves conducting a detailed analysis of the proposed projects' economic viability, which includes estimating the costs, advantages, and risks of alternative possibilities.

The objective of engineering economics is to provide engineers and decision-makers with a tool to make informed decisions regarding the allocation of resources and the design and implementation of engineering projects.

#### Division of Economics

Assumption, Production, Exchange and Distribution.

#### Basic Terminologies

**Demand:** Demand is the amount of a good or service that customers are willing and able to buy at various prices during a predetermined time period

**Supply:** The quantity of a good or service that a manufacturer is willing and able to offer for sale at various prices over a predetermined period of time is referred to as supply.

#### Relation between demand and supply

Market price and quantity can change as a result of changes in supply or demand, creating a new state of equilibrium. As an illustration, a rise in demand for an item or service may cause price increases and commensurate increases in supply. On the other side, a rise in supply can cause prices to drop and the amount demanded to do the same. A crucial component of market economics is the interaction between demand and supply, which explains how prices and quantities are decided in a market-oriented economy.

#### Utility

Utility refers to the satisfaction or pleasure that a consumer derives from consuming a good or service

#### Marginal Utility

The difference in happiness or satisfaction a consumer has after consuming an additional unit of a good or service is known as marginal utility.

It is the utility derived by single unit of consumption.

$MU = \text{Change in Total Utility}/\text{Change in quantity consumption}$

#### Law of Demand

The price of a good increases, the quantity demanded decreases, and as the price decreases, the quantity demanded increases.

The demand curve is a diagram that typically shows this relationship between price and quantity desired as a downward-sloping line. A key idea in microeconomics is the law of demand, which is used to explain and analyze consumer behavior, market dynamics, and corporate behavior.

- Factors influencing demand
- Price of commodity
- Income of consumer
- Price of related goods (competitive or complimentary)
- Weather
- Size of population

- Factors influencing Supply
- Price of commodity
- Price of factor of production
- Price of related goods (competitive/substitute or complimentary)
- Production Technology
- New inventions
- Taxes and subsidies etc.

### Cost Concepts

#### Manufacturing Cost and Non-Manufacturing Cost

**Manufacturing cost:** The costs that are directly related to the production of goods, such as raw materials, labor, and energy also called as direct costs.

**Non-Manufacturing cost:** Refer to all other costs that are not directly related to the production process. These costs are often referred to as indirect costs.

#### Cost of Business Decision

The expenses incurred as a result of selecting one course of action over another are referred to as the cost of a business choice. Both monetary words, such as the direct costs of production, and opportunity costs, such as the value of the best alternative that must be foregone in order to pursue a certain action, can be used to convey this cost.

**Differential cost:** The difference in cost between two alternatives

**Differential revenue:** The difference in revenue between two alternatives, if the differential revenue is positive, it means that one option generates more revenue than the other

**Opportunity Cost:** It is the cost of the best alternative that must be given up in order to pursue a certain course of action.

**Sunk Cost:** Cost that has already been incurred and cannot be recovered.

**Marginal Cost:** The change in total cost that results from producing one additional unit of a good or service.

#### Time Value of Money

**Interest:** It is a fee charged by a lender to a borrower for the use of money

**Simple Interest:** It is a method of calculating interest on a loan or deposit where the interest rate is applied only to the principal amount.

Calculated as,

$$\text{Simple Interest (SI)} = \text{Principal (P)} \times \text{Rate of Interest (R)} \times \text{Time (T)}$$

**Compound Interest:** Interest that is calculated on the initial principal amount and the accumulated interest from previous periods.

**Nominal Rate of Interest:** Standard interest rate that is typically charged for loans or earned on deposits.

Calculated as:

$$\text{Nominal Interest Rate (NIR)} = (\text{Interest Paid} / \text{Principal}) \times (\text{Compounding Frequency} / \text{Time Period})$$

**Effective Rate of Interest:** The actual interest rate that a borrower pays or a depositor earns when the effect of compounding is taken into account.

$$\text{Effective Interest Rate (EIR)} = (1 + \text{Nominal Interest Rate} / \text{Compounding Frequency})^{(\text{Compounding Frequency} \times \text{Time Period})} - 1$$

Where  
Nominal Interest Rate is the stated interest rate that is used to calculate the interest payments on a loan or deposit

Compounding Frequency is the number of times the interest is compounded in a year

Time Period is the length of time for which the loan is taken or the investment is made, typically measured in years.

**Time value of money:** Time value of money is the idea that a dollar today is worth more than a dollar in the future because the dollar received today can earn interest.

#### Cash Flow

The movement of money into and out of a business or individual's accounts

It's a measure of how much cash is being generated or used by a business or individual.

#### Three types

**Operating Cash Flow:** The cash generated or used by a business in its day-to-day operations, such as sales, collections from customers, and payments to suppliers

**Investing Cash Flow:** The cash generated or used by a business in its investing activities, such as buying or selling assets such as real estate, equipment, or securities

**Financing Cash Flow:** The cash generated or used by a business in its financing activities, such as issuing bonds, taking out loans, or paying dividends.

#### Basic Methods of Engineering Economic Studies

##### Minimum Attractive Rate of Return- MARR

It is the interest rate at which a firm can always earn or borrow money under a normal operating environment.

Thus related to either the borrowing interest rate or the lending interest rate.

By assessing the prospective return on investment and determining if it is high enough to justify the investment, the MARR is frequently used as a benchmark for investment decisions and can assist businesses and investors in making wise choices.

##### Payback Period

It is a financial metric that measures the amount of time it takes for an investment or project to recover its initial cost.

Calculated as, Payback period = Initial Investment Cost / Annual Cash Inflow

**Discounted Payback period:** It is a variation of the payback period that takes into account the time value of money.

Calculated as: Discounted Payback Period = Initial Investment Cost / Present Value of Cash Inflow

**Note:** If the discounted payback period is shorter than the simple payback period, it indicates that the investment is more attractive from a financial perspective. If the discounted payback period is longer than the simple payback period, it suggests that the investment may not be as profitable as it appears on the surface.

### Net Present Value (NPV)

It is a financial metric used to determine the value of an investment or project.  
Calculated as,  $NPV = (\text{Present Value of Cash Inflows} - \text{Initial Investment Cost}) / (1 + \text{discount rate})^n$

**Note:** If the NPV is positive, it means that the investment is expected to generate a return that is higher than the discount rate. If the NPV is negative, it means that the investment is expected to generate a return that is lower than the discount rate.

### Rate of Return Method

It is a financial analysis technique used to evaluate the profitability of an investment.  
Calculated as,

$$\text{Rate of Return} = (\text{Gain from Investment} / \text{Initial Investment Cost}) \times 100$$

**Internal Rate of Return:** This method takes into account the time value of money and calculates the rate at which the present value of the expected cash flows from an investment equals the initial investment cost. IRR is widely used in capital budgeting and investment analysis.

Calculated as  $IRR = \text{the discount rate that makes } NPV = 0$

Where  $NPV$  is the present value of the expected cash flows, and the discount rate is the rate used to convert future cash flows into their present value  
Useful for comparing different investment opportunities and determining which one is likely to generate the highest return.

One thing we should be clear on IIR is that it is only an estimate of the return on an investment and does not take into account the risk associated with the investment.

### Depreciation Method

Systematic allocation of the cost of a tangible asset over its useful life.

Factors Affecting Depreciation Amount

1. Depreciable Property
2. Total cost of property
3. Useful life
4. Salvage value
5. Depreciation methods: Book and Tax Depreciation

### Methods:

#### Straight-line method

It is used to allocate the cost of a tangible asset over its useful life

calculated as, Annual Depreciation =  $(\text{Cost of Asset} - \text{Residual Value}) / \text{Useful Life of Asset}$

#### Declining balance method

A method of allocating the cost of a tangible asset over its useful life in a way that recognizes that the asset's value decreases at an accelerated rate over time.

#### More Aggressive than Straight line method

calculated as, Annual Depreciation =  $\text{Book Value of Asset} * \text{Depreciation Rate}$

#### Units of production method

A method of allocating the cost of a tangible asset over its useful life based on the number of units produced or services rendered

calculated as, Annual Depreciation =  $(\text{Cost of Asset} / \text{Total Estimated Units of Production}) * (\text{Actual Units Produced or Services Rendered})$

#### Sum-of-the-year's-digits method

A method of allocating the cost of a tangible asset over its useful life based on a declining balance approach

An accelerated method of depreciation means higher portion of the cost is allocated to the early years of the asset's life and a lower portion is allocated to the later years.

Annual Depreciation =  $(\text{Cost of Asset} * (\text{Years of Useful Life} - \text{Year of Depreciation} + 1)) / (\text{Sum of Years of Useful Life})$

### Taxation System in Nepal

The first income tax was introduced by first elected government in 2016 under finance act. Business and Employment Tax act 2019 enacted till 2031. The Income Tax Act 2031 replaced it, which was further replaced by Income Tax Act 2058, which is the modern tax regulation in Nepal.

The Inland Revenue Department (IRD) oversees the enforcement of tax laws and Administration and also monitors the non-tax revenue such as dividends, royalties etc.

The major sources of government revenue in Nepal are VAT, Custom duty and excise duty

### Types of Tax Revenue

#### Direct Tax

#### Income tax

It is made up of Normal corporate tax, Dividend and Capital Gains

Governed by income tax act 2058(2002) and its subsequent amendments

The income tax rate in Nepal varies depending on the income earned and the status of the taxpayer. For individuals, the tax rate ranges from 1% to 30% on taxable income, with different tax slabs based on income levels. For companies, the tax rate is a flat 25% on taxable income. Non-residents are subject to a flat 15% tax rate on the income they earn in Nepal

#### Vehicle tax

Governed by the Motor Vehicles and Transport Management Act, 2049 (1993).

The amount of vehicle tax in Nepal varies depending on the type of vehicle, its engine capacity, and the purpose of its use. The tax rates are periodically revised by the government, and the current rates can be obtained from the Department of Transport Management or a local tax office.

#### Property tax

Governed by the Local Self Governance Act, 2055 (1999)

As of 2023, the property tax rates in Nepal range from 0.25% to 5% of the assessed value of the property. The rates can vary depending on the location of the property, its use, and the local government's policies.

#### Personal tax in Nepal

The tax is based on the income earned by an individual during a tax year  
As of 2023, the personal income tax rates in Nepal are as follows:

For annual income up to NPR 400,000, the tax rate is 1%

For annual income between NPR 400,000 and NPR 700,000, the tax rate is 10%  
For annual income between NPR 700,000 and NPR 1,000,000, the tax rate is 20%

For annual income above NPR 1,000,000, the tax rate is 30%

It's important to note that these rates are subject to change, and there may be additional tax credits, deductions, and exemptions available to individuals depending on their circumstances.

#### Corporate tax in Nepal

The tax rate for corporate income tax in Nepal is 25%, with certain types of income being subject to different rates.

As of 2023, the corporate income tax rates in Nepal are as follows:  
For companies engaged in the tourism sector, the tax rate is 10%

For companies engaged in the export of goods and services, the tax rate is 20%  
For hydroelectricity companies and other companies engaged in the production of electricity, the tax rate is 20%

For the petroleum industry, the tax rate is 20% for upstream activities (exploration and production) and 7.5% for downstream activities (refining and marketing).  
For banks and financial institutions, the tax rate is 30%. However, there are some additional taxes and levies that may apply to these institutions, such as a 0.2% financial transaction tax on certain types of transactions.

#### Indirect tax

##### Value Added Tax

It is a scientific tax system, which was first introduced in 1954 A.D. in France

Taxes. It was introduced on 16th November, 1997.

There are two rates of VAT: Normal VAT rate is 13%, some goods or services are subject to VAT at 0%.

There are also some goods and services that are exempt from VAT, such as basic food items, health care services, and educational services.  
VAT intended to replace the existing Sales Tax, the Contract Tax, the Hotel Tax and the Entertainment Tax.

##### Custom Duty

Customs duty is a type of tax levied on goods that are imported or exported in and out of Nepal. The rates of customs duty in Nepal are determined by the Customs Act, 2019 and the Customs Rules, 2020. The customs duty rates may vary depending on the type of goods being imported or exported, their origin, and the purpose for which they are being imported or exported.

As of 2023, the general customs duty rate for most goods imported into Nepal is 10% of the value of the goods

##### Excise Duty

The rates of excise duty in Nepal are determined by the Excise Duty Act, 2058 (2002)

Type of tax levied on certain goods produced or manufactured in Nepal.

As of 2023, the general excise duty rate for most goods produced or manufactured in Nepal is 20% of the value of the goods.

## 10.3 PROJECT PLANNING AND SCHEDULING

#### Project Planning and Scheduling

**Project:** a project is a series of activities that need to be completed with the given resources and within the allotted time to achieve a particular goal.

**Project Classification:** There are different ways to classify a project.

- By size - small, medium, mega (cost, duration, manpower, number of departments or entities involved, and so on)
- By type (new, maintenance, upgrade, strategic, operational, etc.)
- By application (software development, new product development, equipment setup or installation etc.)
- Characteristics (level of risks, business values, privacy and ethical values)

**Examples:** Software Development, Data Center Setup, Engineering Construction, Research and Study, Office Setup etc.

#### Project Life Cycle Phases

Project life cycle represents the phases or stages of projects development. Project life cycles are essential for managing projects because they make it easier to plan for resource requirements, schedule appropriate times to evaluate project progress, and determine its status. Additionally, it is a means of simplifying the project task and making the project better manageable.

There are mainly 5 phases in project life cycle.

- Initiation
- Execution
- Completion
- Defining and Planning
- Monitoring and Control

#### **Initiation: Defining what needs to be done**

- Conduct feasibility study
- Define project goals
- Define list of stakeholders and users
- Make project charter
- Create business case

#### **Defining and Planning: Defining how to do what needs to be done**

- Define scope of the project
- Make a project plan and manage the budget in a very scientific way to achieve project goals
- Define roles and responsibilities

#### **Execution: Making a project happen**

- Put the plan into action.
- Allocate and manage resources.
- Execute project effectively and efficiently to achieve the goal.
- Build the product and create deliverables.

#### **Monitoring and Control: Track, review and adjust project progress**

- During implementation, monitoring and control tracks each task's effort, output, and cost and takes appropriate action as needed.
- It is essential to prevent delays and cost overruns while maintaining the desired quality.
- It ensures adherence to plan.

#### **Completion: Ending a project**

- After successful execution of the project, it will be terminated by handing over the deliverables as per the agreed terms and conditions.
- Project results will get approved.
- Document the project learnings.

#### **Project Planning Process**

The project plan acts as a road map for the whole project management procedure. Project planning involves:

##### **Defining Objectives and Scope**

- During planning, objectives and scope of the project must be set with definite words which outline the project's components, primary goal, intended outcomes, various stages of intermediate tasks and closing milestones. All managers and key personnel must have a clear understanding about project's objectives. This should also provide details on what the project intends to solve and who will benefit from the project.

##### **Tasks Scheduling**

- Each task is scheduled on the basis of time frame and resources that provides an estimate of how much time a task would take to complete.

##### **Evaluate the Resources**

- It entails to assess and evaluate the organizational resources to determine whether the organization has the different types of resources available to complete the project by achieving the defined goals and objectives. The defined tasks or actions should be assessed to see what is viable and what is not by analyzing the resources like financial, managerial, manpower and operational resources.

##### **Select the Best Alternative**

- In this step, individual courses of action that need to be carried out are defined using the possible alternatives and the best alternative is chosen by evaluating the company's competency, policy, and resources.

##### **Generate Progress Reporting Guidelines**

- It includes the guidelines for daily, weekly or monthly project reporting outlining the tasks to be completed, the deliverables, and the project's goals as well as the monitoring and controlling activities that need to be performed during project execution.

#### **Project scheduling (Bar Chart, CPM, PERT)**

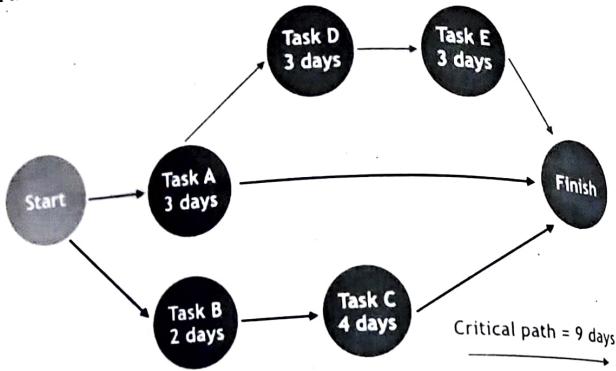
A project schedule is a timetable that organizes tasks, resources, and due dates in the most effective order to enable on-time completion of the project.

##### **Bar Chart**

- Also known as a bar graph or a Gantt chart consists of two coordinate axes, named after H.L. Gantt who published one of the first known bar charts in 1931.
- A bar chart is a visual tool that may be used to present data in a way that is simple to read, understand and allows for easy comparison of all the presented data.

- The chart can be used to offer data from the individual schedule activities and project-related information.
- The vertical axis of a bar chart symbolizes the tasks to be completed, and the horizontal axis the time elapsed.
- The start and end times of each action are shown by a bar.

### Critical Path Method (CPM)



- CPM is a project modeling technique developed by Morgan R. Walker and James E. Kelley Jr. in the late 1950s.
- The CPM is a network technique used for planning, scheduling and controlling of the project. It is a method for identifying tasks required for project completion and determining schedule flexibility.
- In project management, the longest series of tasks that must be finished on schedule for the completion of the project is known as a critical path.

### Program Evaluation and Review Technique (PERT)

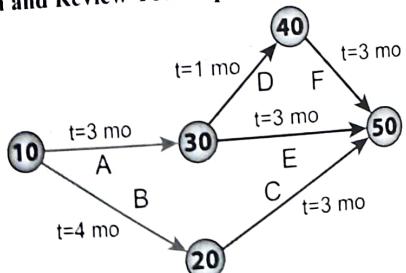


Figure: PERT chart for a project with five milestones (10 through 50) and six activities (A through F).

Developed by the US Navy Special Projects Office and the Operations Research Department of Booz-Allen-Hamilton.

PERT is an event-oriented method of network planning.

PERT is used to identify the time it takes to finish a specific task or activity. It is a system that helps in the proper scheduling and coordination of all the activities throughout a project.

### Resource Levelling and Resource Smoothing

- Resource leveling is the practice of adjusting project's start and end dates to account for limited resources. In contrast, resource smoothing requires the adjustment of project's activities to ensure that the work is finished within the existing timelines.
- Resource levelling is utilized when the availability of resources is constrained.
- Resource smoothing is employed when there is time is of the essence and the goal is to finish the work by the deadline without causing resource demand to spike or fall.

### Monitoring, Evaluation and Controlling

- Project monitoring, evaluation and controlling is a continuous management function to assess if progress is made in achieving expected results, to identify implementation bottlenecks, and to determine any unintended consequences (which may be positive or negative) of an investment plan or project and its activities so that the corrective measures can be taken to address the issues.

### Project Management Information System

- A project management information system (PMIS) is a software application that organizes and controls the flow of a project data and information to assist a project manager in the development of the project.
- A PMIS helps project managers to plan, monitor, and execute project deliverables like schedules, costs, executions and results more effectively and efficiently.
- The goal of PMIS is to automate, organize and provide control of the project management processes.

### Project Risks Analysis and Management

- Risk analysis involves analyzing how project goals and objectives might vary due to the impact of the risk occurrence.
- Risk analysis is a systematic process to evaluate the level of risk for the identified and approved risks. Moreover, it involves estimating the probability of occurring any events and their potential impacts on project execution.

- Depending on the data availability and project objectives, the most commonly used risk analysis methodologies are qualitative and quantitative. Quantitative risk analysis is based on the verified and specific, whereas qualitative risk analysis is based on an individual's perception or judgment.



- Benefits of risk assessment
  - Protection of investment in a project
  - Assist in proactive management through early warning
  - Helps to effectively achieve project goals and objectives

### Project Financing

- Financing is a broad term that encompasses activities connected to banking, leverage, credit, capital markets, money, and investment.
- Project finance deals with financial aspects of a specific project that involves analyzing the feasibility of a project and its funding needs on the basis of cash flows that the project is expected to produce.
- Project finance is used for long-term industrial, infrastructure and public service delivery projects, including the government.

### Tender and its process

- Tendering is the process of inviting for bid, proposal or expression of interest (EOI) by the client to the contractor (supplier, construction company, software developing firms or service provider etc.) for the execution of a project at specified cost in the specified time.
- It is published in the form of tender notice in the national newspaper and on client's website.

### Types of procurement through tender

- Tender for construction work – construction of road, building, tunnel etc.

For the procurement of goods – procurement of computer hardware, medical equipment, vehicles etc.  
For the procurement of service – procurement of expert service for software development, research and development, support service, DPR preparation etc.

of Tenders

for procurement of goods, construction works or other services:

i. International Competitive Bidding – for very big projects

ii. National Competitive Bidding – for large projects

iii. Sealed Quotations – for medium size projects

iv. Direct Procurement – for small projects (both goods and services)

v. Through participation of users' committee or beneficiary group – for the local community based specific projects

Procurement of consultancy services:

i. By requesting competitive proposals

ii. Through direct negotiations

Two stage bidding – Applied for the complex projects. In two-stage tendering, the bidders are requested to submit the general framework of a tender without price specifications in the first stage and the contracting authority invites the bidders selected to submit final tenders together with price specifications in the second stage.

Limited tender: only a selected number of bidders are invited to quote their rates.

Single tender: Only one company is invited to submit an offer for the given work or service by referencing their rating. If the quoted rates are too high, it will be negotiated before the contract is signed.

Rate contract: This is typically used for the provision of equipment, machinery, tools, and plants. It details the supply at a fixed price for the duration of the contract.

### Contract Management

After awarding the tender to the best bidder (lowest substantial bid), the authorities of the client office and contractor make contract in the presence of the witnesses. The purpose of contract management is to ensure the rights and duties of each party to ensure the project completion and delivery on time with right quality and on within approved budget. It includes at least monitoring, controlling and performance evaluation, progress reporting, change management, dispute resolution, financial management and payment, budget and time adjustment in critical situations etc.

## 10.4 PROJECT MANAGEMENT

### Project Management

Project management is the process of directing a project from start to finish that involves planning, organizing, and managing resources to achieve specific goals and meet project requirements. This includes project scope, goal and objective definition, team formation and management, budgeting, planning and progress tracking to ensure successful project completion.

### Information System

An Information System (IS) in project management is a set of hardware, software, data, people, and procedures that work together to produce and manage information. In the context of project management, an IS can support various project management functions, such as project planning, monitoring, and control, by providing real-time data and analytics.

An Information System (IS) in project management can support project management functions in several ways:

**Project Planning:** IS can offer project managers pertinent data and information to support project planning tasks such as establishing the project's scope, specifying its goals and objectives, establishing work breakdown structures, and producing project timelines and budgets.

**Monitoring and Control:** Project managers can monitor project progress and control project results with the aid of real-time data and analytics provided by IS. Software for project management, for instance, can be used to properly assign resources, track work completion, and identify risks and difficulties.

**Collaboration and communication:** By offering a centralized forum for knowledge sharing and idea exchange, IS can facilitate collaboration and communication among project team members and stakeholders. For instance, by enabling real-time communication amongst team members, collaboration technologies like Slack can enhance teamwork. IS can assist with crisis management and risk management.

**Risk management:** By giving project managers information and insights into potential risks and hazards, IS can enhance risk management efforts. Dashboards and reporting systems, for instance, can assist project managers in identifying possible risk areas and taking preemptive measures to reduce any adverse effects.

### Project Risk Analysis and Management

The process of locating, evaluating, and minimizing any risks that can affect the successful execution of a project is known as project risk analysis and management. It entails using a methodical process to assess the possibility and consequences of prospective risks and to create mitigation plans.

- Risk Identification:** This helps to identify potential risks and hazards, both internal and external, that could have an effect on the project.
- Risk Assessment:** This involves evaluating the likelihood and impact of each identified risk and prioritizing the risks based on their potential impact.

**Risk Response Planning:** Creating plans to lessen or control the effects of the most important hazards. This could entail taking steps to lessen the risk's likelihood or creating backup plans to deal with the impact if the risk materializes.

**Risk Monitoring and Control:** Monitoring the progress of risk mitigation strategies and taking corrective action if necessary.

### Project Financing

It is the use of a non-recourse or limited recourse financial structure to fund long-term infrastructure, industrial projects, and public services.

There are several sources of project financing, including

- Debt Financing:** In order to finance the project, money is borrowed from banks, financial institutions, or bond markets. Usually backed by the project's assets, this kind of financing has a specified repayment schedule.
- Equity financing:** entails obtaining funds from investors in exchange for a share in the company. This kind of finance is frequently applied to start-up businesses or to offer extra funding for ongoing projects.
- Public-Private Partnerships (PPPs):** are arrangements where the private and public sectors work together to finance, build, and maintain infrastructure projects. PPPs are gaining popularity as a means of financing large, complex projects that demand a sizable investment.

### Tender and its process

The tender process in Nepal is a competitive bidding process used to award contracts for procurement of goods, works, or services by the government or private sector organizations.

The goal of the tender procedure is to choose the offer that is economically advantageous and satisfies the technical and quality requirements.

The following are the key steps involved in the tender process in Nepal:

#### • Invitation for Bids

Inviting all interested parties to make bids for the purchase of products, services, or works. The specifications, terms, and guidelines for the tendering process will be included in the request for bids.

#### • Bid Preparation

In order to do this, a bid must be prepared and submitted in response to the request for bids. The offer must adhere to the specifications and guidelines stated in the request for bids.

#### • Bid Evaluation

In order to establish which bid represents the most value for money, the bids that were submitted in response to the request for bids must first be evaluated. Price, quality, technical requirements, delivery schedules, and other relevant aspects may be included in the evaluation criteria.

- **Award of Contract**

Giving the winning bidder the contract and delegating delivery of the goods, works, or services to them in accordance with the contract's terms and conditions.

The tender process in Nepal is designed to ensure fairness, transparency, and competition in the procurement process. By following the tender process, organizations can select the most economically advantageous offer, improve efficiency and reduce corruption in procurement, and promote economic growth in Nepal.

The tender process in Nepal is governed by a number of laws and regulations which are

- Public Procurement Act, 2063
- Public Procurement Regulation, 2064
- Competition and Consumer Protection Act, 2063

International treaties, such as the Agreement on Government Procurement under the World Trade Organization (WTO), which lays out the guidelines for procurement by WTO member nations, may also have an impact on Nepal's tender process in addition to these laws and regulations.

### **Contract Management**

The process of overseeing and administering contracts for goods, works, or services between organizations and their suppliers, contractors, or other parties. The objective of contract management is to ensure that contracts are executed efficiently and effectively, and that the terms and conditions of the contracts are fulfilled.

The following are the key steps involved in contract management in Nepal:

- A. Contract Preparation
- B. Contract Execution
- C. Contract Monitoring and Administration
- D. Contract Closeout

An essential component of supply chain and procurement management in Nepal is contract management. Organizations may improve the effectiveness of their procurement procedures while receiving the best value for their money, lowering the risk of litigation and disagreements, and managing contracts effectively. Effective contract management can also encourage cooperation and trust between businesses and their vendors, contractors, or other partners.

## **10.5 ENGINEERING PROFESSIONAL PRACTICE**

### **Environment and society**

- Sustainability is essentially the relationship between the environment and society.
- The relationship between the environment and society is affected by the technologies, understanding of environment and our ethical attitude.

### **Influence of society in environment**

- Climate change
- Soil erosion and pollution
- Water pollution
- Depletion of resources

### **Influence of environment in society**

- Influence of plains: population, economic life
- Influence of hills: population, economic, social life
- Influence of desert: economic life, social life

### **Professional ethics**

- A profession is a job that requires specific training and is regulated by certain standards.
- Ethics is also known as moral philosophy.
- It is branch of philosophy that involves systematizing, defending and recommending concepts of right or wrong behaviour.
- Professional ethics encompasses the personal and corporate standards of behaviours expected of professionals.
- Professional ethics is concerned with one's behaviour and conduct when carrying out professional work. It is confined and varies across different cultures.
- Professional ethics are the ethical norms, values and principles that guide a profession and the ethics of decision made with the profession.

### **Components of ethics**

#### a. Honesty

- Honesty refers to a facet of moral character and denotes positive, virtuous attributes such as integrity, truthfulness and straightforwardness along with the absence of lying, cheating or theft.
- According to William Shakespeare, honesty is the best policy. If I lose mine honour, I lose myself.

#### b. Integrity

- Integrity is a concept of consistency of actions, values, methods, measures, principles, expectations and outcomes.
- Integrity can be regarded as the opposite of hypocrisy, that it regards internal consistency as a virtue.
- The word integrity derived from the Latin adjective integer that means wholeness.

#### c. Transparency

- Transparency is a general quality.
- It is implemented by a set of policies, practices and procedures.
- It allows citizens to have accessibility, usability, utility, understandability, informativeness and auditability of information and process held by centers of authority.

- d. **Accountability**
- It is often used synonymously with such concepts as answerability, blameworthiness, liability and other terms associated with the expectation of account giving.
  - It is the acknowledgement and assumption of responsibility for actions, products, decisions, and policies and be answerable for resulting consequences.
  - It can not exist without proper accounting practices.

- e. **Confidentiality**
- It is an ethical principle of discretion associated with the professions such as medicine, law, psychotherapy.
  - In law and mediation there exist communications between the client and professional which are privileged communications.
  - In business, the confidentiality of information a mainstream adaption of the need to know.
  - In military it is a basic to security of corporate information.

- f. **Objectivity**
- Objectivity is a principle of journalistic professionalism.
  - In journalism, objectivity may synonyms with neutrality.
  - Objectivity in journalism enables highly accelerated news reporting and delivery which sometimes is at tension with standards of objectivity.

- g. **Respectfulness**
- Respect gives a positive feeling of esteem for a person and conduct representative of that esteem.
  - Respect can be a specific feeling of regard for the actual qualities of one respected.
  - Rude conduct is usually considered to indicate a lack of respect, disrespect, whereas actions that honour somebody or something indicate respect.
  - The opposite of respect is contempt.

- h. **Obedience to the law**
- Law is the set of enforced rules under which a society is governed.
  - Law is one of the most basic social institutions and one of the most necessary.
  - The law thus establishes the rules that define a person's rights and obligations. The law also sets penalties for people who violates the rules.
  - In fact, laws frequently are changed to reflect changes in a society's needs and attitudes.
  - Law is system of rules and guidelines which are enforced through social institutions to govern behaviour.
  - The formation of laws themselves may be influenced by a constitution.
  - The law shapes politics, economics and society in countless way and serves as a social mediator of relations between people.

## Regulatory environment

Regulatory environment is the system of rules and principles government the conduct of and relations between states and international organization as well as some of their persons.

In Nepal, following are the professional regulatory environment:

### Labour law

- a. The Labour Act, 2074 has replaced the previous labour law completely i.e. Labour Act, 2048 has ceased to be in effect.
- Working hours is only 8 hours a day, 48 hours /weak (labour act 2074), and 8 hours a day, 40 hours/week (labour act, 2048).
  - Overtime rate is 1.5 times the basic hourly rate.
  - Part time Employment: employment for 35 or less hours in a week.
  - Where 20 or more employees are engaged, employer shall constitute a Safety and Health Committee.
  - Where 10 or more employees are engaged in the entity, employer shall also constitute the Collective Bargaining Committee.

### Cyber law

- In Nepal, the Nepal Police have been using the Electronic Transactions Act 2063 to regulate cybercrimes.
- Cyber law provides legal basis for appropriate use of electronic devices and communication technology by a person, organization and the government office.
- Cyber law controls the crime through the use of computer and electronic devices.
- It protects child's rights and also prohibit the child pornography.
- Cyber law is related to the copyright act, hence it helps to protects the copyrights of idea including computer program.

### Contract law

- All the functions and task performed between two parties must be done with valid contract between them.
- If someone violates the rule and made to work something without contract, he/she will be punished.
- The PPMO has developed rules and regulations about contract to perform the task, consulting etc.
- The contract between company and labour/worker is also mandatory from the view point of tax audit and labour right.
- Contract must define all the aspects of project or work and must be successful to made parties enforced by law.

**d. Intellectual property right**

- Intellectual property right refers to creation of mind, such as inventions literary and artistic works, design and symbols, names and image used in commerce.
- Intellectual property rights are the rights that allow creators or owners of patents, trademarks or copyrighted works to benefit from their own work or investment in a creation.

**Patent**

- A patent is a monopoly right granted to a person who has invented a new and useful article or an improvement of an existing right to new process of making an article.

**Trademark**

- Trademark is a sign which is capable of distinguishing the goods or service of one enterprise from those of other enterprises.

**Copyright**

- Copyright is a type of intellectual property that protects original works of authorship as soon as an author fixes the work in a tangible form of expression.

**e. Nepal engineering council act**

- Therefore, to make the engineering profession more effective, Nepal Engineering Council was formed under the Nepal Engineering Council Act, 2055 promulgated by His Majesty the King on B.S. 2055/11/27 (11th March, 1999 A.D.).
- As per the Act, NEC has been vested with the statutory authority for the planning, coordinated development and monitoring of engineering profession and education in the country.
- NEC Act 2055 gives an outline on the formation of the Council, its tenure and the roles and responsibilities of the Chairman, Vice Chairman and the Registrar.

**f. Relationship between international firms**

- For technology transfer in legal basis international firms may active in association with government of Nepalese firms.
- Helps to develop new business in country.
- Promotion of foreign investment.

**g. Company registration**

- For the execution of any task from government, company may necessary.
- Company may be private or public limited company may require as per size, nature and business environment within the country.
- Company must be registered in government of Nepal office of company registration with valid documents by defining its scope and objectives.
- A public company requires a minimum of NPR 1,00,00,000 as a paid-up capital to begin the registration process.
- A private company requires only a minimal paid up capital, i.e. NPR 1,00,000.

**Contemporary issues/problems in engineering**

**Globalization and cross culture issues**

- Rapid development in transportation.
- Need to understand cross culture issues.
- Developing effective relationship between the people of different cultures.
- Acceptance of power and authority.

**World trade organization perspective**

- The organization is for maintaining the global business.
- WTO deals with the regulation of trade among members countries by providing a framework for negotiating and formalizing trade agreements and disputes resolution.
- WTO promotes world trade in a standard way.

**Public private partnership**

- Involvement of government office and private companies to execute a task under the mutual understanding and terms conditions.
- Private party provides a public service or project.
- The investment may be of sole of private company or may be done based on divided share values between them.
- This method is sustainable and secure business model.
- If government willing to develop project in association with private organization for the public benefit, PPP model gets succeed.

**d. Development versus environmental degradation**

- Development, urbanization, production, internet and other facilities are becoming challenging to our environment.
- Development must be undertaken by considering the non-degraded environment after its implementation.
- Development activities should be of sustainable type.
- Due coordination between the executive private or government organization and environmental department for the sustained development.
- The Environment Protection Act, 2019 (2076) must be taken into consideration during sustainable design and implementation.

**e. Addressing the climate change issues**

- Climate change is the big issue all over the world.
- Development of GLOF, melting of ice cap, vanishing of different lives and species from our surrounding are the result of climate change.
- Development activities must be environment friendly and sustainable.

**f. Conflict and dispute management**

- Conflicting activities must be minimized from project developer.

- Conflict between company and workers, client and company, company and public and public and government may disturb the progress of work.
- A state of discord caused by the actual or perceived opposition of needs, values and interests between people working together is called organizational conflict.
- Level of conflict are intrapersonal conflict, interpersonal conflict, intergroup conflict, inter-organizational conflict and international conflict etc.

#### Sources of conflict

- |                                      |                                       |
|--------------------------------------|---------------------------------------|
| • Personal difference                | • Goal and role incompatibility       |
| • Organizational climate and change  | • Gender and other social differences |
| • Availability and access to sources | • Communication gap                   |

#### Conflict resolution methods

- |                |                 |
|----------------|-----------------|
| • Avoidance    | • Diffusion     |
| • Containment  | • Confrontation |
| • Conciliation | • Mediation     |
| • Arbitration  | • Litigation    |
| • Adjudication |                 |

#### Occupational health and safety

- The highest degree of physical, mental and social well-being of workers in all occupations is known as occupational health.
- The science of anticipation, recognition, evaluation and control of hazard arising in or from the workplace which could impair the health and well being of workers is called occupational health and safety.
- International labour organization (ILO) has maintained and developed a system of international labour standard since 1990, which aimed at promoting opportunities for decent and productive work in conditions of freedom, equity, security and dignity.

#### Major aims of occupational health and safety

- Promotion and maintenance of the well-being of workers in all occupations.
- Prevention of departures from health caused by working conditions.
- Protection from risk resulting from factors adverse to their health.
- Placing and maintenance of the worker in an environment adapted to their psychological and physiological condition.
- The high illiteracy among the workers, lack of awareness, avoidance of safety rules, inattention of the concerned government authorities in implementation of occupational health and safety have increasing health and safety issues in Nepal.

#### Causes of occupational hazard

- Unsafe working conditions
- Lack of supervision and training to the workers.

- Use of old machinery and equipment
- Lack of sufficient maintenance.
- Bad housekeeping practice.
- Violation of safety rules during working hours.

#### High risk works

- Working with machine and equipment
- Use of electricity
- Use of toxic chemicals
- Dusty worksites
- Congested and dark working places.

#### Roles and responsibilities of Nepal engineer's association

- Nepal Engineers' Association (NEA) is an independent non-profit organization of Nepalese engineers, registered under the Social Service Act of the Government of Nepal.
- It was established in 1962.
- NEA is governed by an elected executive council of 25 members, led by the President of the association for a tenure of two years.
- NEA has established centers for Continuous Engineering Education and the Business Incubation Center to address respectively the CPD requirements for professional enhancements and to promote entrepreneurship capabilities among the young engineers.
- NEA facilitates and coordinates the professional activities of the independent subject-specific professional societies.

#### 10.6 ENGINEERING REGULATORY BODY

**Nepal Engineering Council Act 2055 (1999): Date of Royal Seal and Publication  
2055-11-27 B.S. (March 9, 1999 A.D.)**

Nepal Engineering council was established to make the engineering profession more effective in Nepal under the Nepal Engineering Council Act, 2055. NEC gains the authority to plan, coordinate, develop and monitor the engineering profession and education inside the country.

#### Nepal Engineering Council Act 2057

Nepal Engineering Act 2057 lies under the Engineering council Act 2055, section 37. As per the provision of clause 37 of the Act, Nepal Engineering Council Rules 2057 has been prepared and approved by the Nepal Government. The registration of engineers can be done in 3 categories:

##### A. General Registered Engineer - Category 'A'

Requirement: At least Bachelor's degree in any Engineering faculty.

##### B. Professional Engineer - Category 'B'

Requirement: At least Master's Degree in any Engineering faculty.

### C. Non-Nepali Registered Engineer – Category 'C'

Requirement: At least Bachelor's degree in any Engineering faculty with minimum working experience of 10 years in engineering field.

### Nepal Engineering Council (First Amendment) Act, 2079

In 2076 BS, the federal parliament received the bill for the amendment of the engineering council but the file was under the table for three years. Finally, the bill is passed on Bhadra-5, 2079 BS. As per the provision of clause 17 of the Act 2079 BS, Nepal Engineering Council will take the Engineering License Examination and the students will have to pass the exam. After passing the exam, students shall be registered as an Engineer into Engineering Council Registration Book.

### Vision of Nepal Engineering Council

The vision of NEC is to make the engineering profession effective by mobilizing it in a more systematic and scientific and also to register the engineers as per their qualifications.

### Scope of Nepal Engineering Council

1. Licensing of Engineers
2. Accreditation of certificates of academic qualification
3. Recognition of the academic institutions
4. Professional code of conduct

### Objectives of the NEC

Mobilizing engineering council's resources in systematic, and scientific way to make the engineering profession in Nepal more effective is the objective of Nepal Engineering Council. Some of the duties and responsibilities of Engineering Council are:

1. For smooth functioning and executing of the engineering profession, NEC prepares policies, plans and programs.
2. Set norms and standards for engineering education in Nepal.
3. Grant permission and approval to carry out engineering education to those engineering colleges that meet the required norms and standards.
4. Monitor and inspect the quality of engineering education provided by the engineering colleges and institutions.
5. Fix the necessary qualification in order to practice engineering profession and register the engineers in the council and provide them the engineering license.
6. Cancel the registration of engineer from the register list if found violation of the code of ethics that has been published by NEC.

### Nepal Engineering Council: Professional Code of Conduct

The professional Code of Conduct to be followed by the registered Engineers of the Council, subject to the provision of the Nepal Engineering Council (NEC) Act, 2055 (1998) and the Nepal Engineering Council Regulation, 2057(2000), has been published as follows:

1. **Discipline and Honesty:** The Engineering service/profession must be conducted in a disciplined manner with honesty, not contravening professional dignity and well-being.

2. **Politeness and Confidentiality:** Engineering services for customers should be dealt with in a polite manner and professional information should remain confidential except with written or verbal consent of the customers concerned. This, however, is not deemed to be a restriction to provide such information to the concerned authority as per the existing laws.
3. **Non-discrimination:** No discrimination should be made against customers on the grounds of religion, race, sex, caste or any other things while applying professional knowledge and skills.
4. **Professional Work:** Individuals should only do professional work in their field or provide recommendations or suggestions only within the area of their subject of study or obtained knowledge or skills. With regard to the works not falling within the subject of one's profession, such works should be recommended to be done by an expert of that subject matter.

5. **Deeds which may cause harm to the engineering profession:** With the exception of salary, allowance and benefits to be received for services provided, one shall not obtain improper financial gain of any kind or conduct improper activities of any kind, which would impair the engineering profession.

6. **Personal responsibility:** All individuals will be personally responsible for all works performed in connection with his/her engineering profession.

7. **State name, designation and registration no.:** While signing the documents or descriptions such as the design, map, specifications and estimates etc., relating to the engineering profession, the details should include, the name, designation and NEC registration No. and should be stated in a clear and comprehensible manner.

8. **No publicity or advertisement must be made which may cause unnecessary effect:** In connection with the professional activities to be carried out, no publicity or advertisement shall be made so as to cause unnecessary effect upon the customers.

### Note:

- Engineers, working with government, quasi government, private sectors, NGOs, INGOs, bilateral and multilateral agencies and consultants etc., if not registered with NEC, can be punished as it would be against the Law of Land.
- NEC is not responsible for registering engineers who complete their studies from any institute or through any engineering programs unless and until such programs are inspected/monitored & approved by NEC.

### Important points on professional code of conduct:

1. Engineers must be honest and be in discipline during their professional work/ service tenure without letting engineering profession's morale down.
2. Engineers must be loyal to the organization to which they are involved, their clients, employers, peers, third party vendors etc.
3. In the name of religion, color, sex, caste there should not be impartiality/ discrimination between people while practicing engineering professional knowledge and skills.

- Engineers must perform the professional work what he is supposed to do or capable of which faculty engineering licensing he is registered with. He/ She should not practice or their engineering knowledge on out of scope of their education, profession, knowledge, experience, skills etc. E.g., A computer engineer is not supposed to survey a Road.
- Never let engineering profession down during performing engineering jobs by not taking bribes, improper/ excess financial gain with non-justifying source of income.
- Take the complete responsibility of your tasks or duties.
- Always write your name, designation, NEC registration number whenever you are supposed to sign on the official documents like engineering designs, documents, maps, specifications, quotations etc.
- Not to publish any notice/ information which might bring higher influence to the public unnecessarily.

#### **Section 5. Nepal Engineering Council Act, 2055**

- There are three members formed as an inspection committee under the coordination of council member. The committee can inspect/ examine complaints that has been filed of registered at engineering council against an engineer.
- Those people or recently university passed out students who are not registered in the Nepal engineering council should not perform any engineering profession. This rule will be effective after one year from the implementation of NEC Act, 2055.

#### **Removal of Registered Engineer Name from Register Book**

- If the person is mentally ill.
- If the person is bankrupt (unable to pay back loans).
- If the person has violated NEC's professional code of conduct and filed a case against him in NEC to remove the name from the registration book is passed by two third majority.
- If the court finds the person is guilty in criminal charge.
- If the person who is out of engineering background or the person who has not passed engineering course from recognized college or institutions has been registered to engineering council by fraud or by error.

#### **Cancellation of the Engineering Certificate**

In accordance with the section 18, if incase the Nepal Engineering Council takes and approves a decision to cancel the engineering license by removing the name of the person from the register book, the Registrar of the Engineering Council will remove the name of the person from registration book also cancels the issued certificate and provide information to the concerned/ ineligible person.

#### **Re-registration of Name in Register Book**

Person is applicable to re-register his/her name to the engineering council only after one year period his registration has been cancelled. Nepal Engineering Council only accepts reasonable cause for re-registration.

# **MULTIPLE CHOICE QUESTIONS**

## **10.1 Engineering Drawing and Its Concepts**

- \_\_\_\_\_ is a two-dimensional representation of three-dimensional objects.
  - Engineering Sketching
  - Engineering Painting
  - Engineering Architecting
  - Engineering Drawing
- \_\_\_\_\_ is also called the universal language of engineers.
  - Engineering Sketching
  - Engineering Painting
  - Engineering Structuring
  - Engineering Drawing
- The person who possesses an engineering drawing knowledge has ability to \_\_\_\_\_
  - Read, Prepare and Understand the Engineering Drawing
  - Create or draw rough hand sketch
  - Visualize the objects
  - Understand other objects
  - All of above
- Engineering drawings are prepared on standard size \_\_\_\_\_
  - Drawing Boards
  - Drawing Sheets
  - Any white sheets
  - All of above
- The drawing boards used to draw an object is made up of softwood of thickness about 25 mm. with a working edge for \_\_\_\_\_.
  - Chi- Square
  - Set- Square
  - T- Square
  - P- Square
- Present days \_\_\_\_\_ are used instead of T-squares which can be fixed on any board.
  - Mini-draughts
  - P-square
  - Set-square
  - None of above
- Set squares contains \_\_\_\_\_ angles most commonly used in engineering drawing.
  - 30, 45, 60 and 90
  - 45, 60, 90 and 180
  - 30, 60, 90 and 270
  - 30, 45, 60 and 360
- Consider a diagram below in which angles produced by set squares are combined to obtain new angle. What is the value of  $x$ ? [For your reference, please consider figure 1: set squares to identify which degree set squares are used in above diagram].
 

$x = ?$

  - $x = 20$  degree
  - $x = 45$  degree
  - $x = 15$  degree
  - $x = 5$  degree