Engineering Drawing  ME 111  1-0-3-5

Instructors: Dr. Sreeja P. (CE),
Dr. S. Senthilvelan (ME) and
Dr D. Sharma (ME)

Course Credits

• 1-0-3-5
  – 1: One lecture per week. However, we need more lectures per week for better understanding of this course
  – 0: No tutorial
  – 3: one lab of three hours
  – 5: Total credits for this course
Course Information

• Lectures
  – **FN** (D slot) Division I by Dr. S. Senthilvelan (ME) and Division II by Dr. Sreeja P. (CE)
    • **Venue**: Lecture Hall – L1 (Div I), and L2 (Div II)
  – **AN** (D1 slot) Divisions III by Dr. D. Sharma (ME) and Division IV by Dr. Sreeja P. (CE)
    • **Lecture schedule**: Monday: 2-2:55PM, Thursday: 4-4:55PM, Friday: 3-3:55PM
    • **Venue**: Lecture Hall – L1 (Div III), and L2 (Div IV)
  – Lecture slides
    • On moodle under “Mechanical Engineering”.
      – The course name is “Engineering Drawing 2014” and password is “ed2014”.
    • **For first two weeks only, the slides will also be available at “http://shilloi.iitg.ernet.in/~dsharma/me111.html”**

Lab Sessions

• Drawing halls: 1205 and 1206, Core 1

<table>
<thead>
<tr>
<th>FN Lab session (9-12noon)</th>
<th>AN Lab session (2-5PM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME111 (L8)</td>
<td>ME111 (L3)</td>
</tr>
<tr>
<td>ME111 (L6)</td>
<td>ME111 (L1)</td>
</tr>
<tr>
<td>ME111 (L9)</td>
<td>ME111 (L4)</td>
</tr>
<tr>
<td>ME111 (L7)</td>
<td>ME111 (L2)</td>
</tr>
<tr>
<td>ME111 (L10)</td>
<td>ME111 (L5)</td>
</tr>
</tbody>
</table>

• Tables in both drawing halls will be arranged with registration number on it.
• Details of seating arrangement will be uploaded on http://shilloi.iitg.ernet.in/~dsharma/me111.html
Why Drawing for Engineers?

Engineering is the profession in which a knowledge of the mathematical and natural sciences gained by study, experience and practice is applied with judgment to develop ways to utilize economically the material and forces of nature for the benefit of mankind - ABET (Accreditation Board for Engineering and Technology).

- In a process of product development, two steps are involved:
  - **Product specification**
  - **Product drawing**

Although the works of artists (or photography and other method of reproduction) may provide pictorial representation, they cannot serve as engineering descriptions.
A new machine, structure, product must exist in the mind of the engineers before it can become a reality.

- Original concept or idea is usually placed on paper or as an image on a computer screen and,
- Communicated to others by way of the graphic language in the form of freehand sketches.
- These free hand sketch are followed by other, more exact, sketches as the idea is developed more fully.

The engineer must understand how to read and write in the graphic language

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Engineers must be able to create idea sketches, calculate stresses, analyze motions, size parts, specify materials and production methods, make design layouts and supervise the preparation of drawings and specifications that will control the numerous details of product manufacture, assembly and maintenance.
Although people around the world speak different languages (about 7000), a universal graphic language has existed since the earliest times.

The earliest forms of writing were through picture forms such as *Egyptian hieroglyphics*. Later these forms were simplified and became the abstract symbols used in our writing today.
**Drawing** is a graphic representation of:

- a real thing,
- an idea or,
- a proposed design for later manufacture or construction.

**Graphic representation:**

1. Artistic: to express aesthetic, philosophic or other abstract ideas
2. Technical: to represent the design of objects to be built or constructed
What Engineering Students Should Know?

• For any product design or development, graphical language is always required with technical knowledge
  • Today the intimate connection between engineering and science, and the universal graphic language is more vital than ever before
  • Artistic talent is no longer a prerequisite to learning the fundamentals of the graphic language.
    • Instead today’s graphics student needs the same aptitudes, abilities and computer skills that are needed in science and engineering courses
  • A well trained engineers must be able to make and read correct graphics representations of engineering structures, designs and data relationships.
    • Understand the fundamental principles or the grammar of the language and be able to execute the work with reasonable skill

What Engineering Students Should Know?

• Students will learn the meaning of neatness, speed, and accuracy for the first time in a drawing course. These are basic and necessary habits for every successful engineer
  • The ability to think in three dimensions
    • Learning to visualize objects in space, to use the constructive imagination is one of the principal values to be obtained from a study of the graphic language
Projections

Behind every drawing of an object is a space relationship involving four imaginary things:
- The observer’s eye or the station point
- The object
- The plane of projection
- The projectors also called visual rays or lines of sight

If the observer’s eye is imagined as infinitely distant from the object and the plane of projection, the projection will be parallel.

If the projectors, in addition to being parallel to each other, are perpendicular (normal) to the plane of projection, the result is an orthographic.

If the projectors are parallel to each other but oblique to the plane of projection, the result is an oblique projection.
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*Syllabus:* Importance of engineering drawing; Conventions and standards: ISO; Scales; Curves; Orthographic projections: points, lines, planes and solids; Sections of solids; Isometric projections; Development of surfaces; Intersection of solids

*Texts:*

*References:*

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**Weightage**

50 % Lab sessions  
20 % Mid-semester exam (20th September 2014)  
30 % End-semester exam (08th and 09th November 2014)

**Normalization**

a. Group wise for lab sessions.  
b. Session wise for end semester exam.
Lab sessions

<table>
<thead>
<tr>
<th>Lab No</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lettering, Dimensioning and Engineering Curves: Parabola, Ellipse, Hyperbola, Cycloids and Involute</td>
</tr>
<tr>
<td>2</td>
<td>Scales: Plain, Vernier and Diagonal scales</td>
</tr>
<tr>
<td>3</td>
<td>Orthographic projections:</td>
</tr>
<tr>
<td>4</td>
<td>Projection of straight lines I: Lines inclined to any one of the plane</td>
</tr>
<tr>
<td>5</td>
<td>Projection of straight lines II: Lines inclined to both HP and VP, traces</td>
</tr>
<tr>
<td>6</td>
<td>Projection of solids I: Projections of solids in simple positions</td>
</tr>
<tr>
<td>7</td>
<td>Projection of solids II: Solids inclined in to one and both the planes</td>
</tr>
<tr>
<td>8</td>
<td>Sections of solids: Section of standard solids and True shape Section of standard machine elements</td>
</tr>
<tr>
<td>9</td>
<td>Development of surfaces: Development of standard solids full and sectioned solids</td>
</tr>
<tr>
<td>10</td>
<td>Isometric projections: Isometric projections of simple solids, simple and complex positions</td>
</tr>
</tbody>
</table>

- Common questions will be discussed in the lecture.
- Sheets will be graded out of 100 marks.
Attendance

• Minimum 75% compulsory attendance in lectures and labs separately
• Four times updates of attendance will be available on moodle

Prerequisite For Engineering Drawing

Table 1.1 Recommended Sizes of Drawing Sheets and Drawing Boards

<table>
<thead>
<tr>
<th>Designation</th>
<th>Size (mm)</th>
<th>Drawing Sheet (IS 10711:2001)</th>
<th>Designation</th>
<th>Size (mm)</th>
<th>Drawing Board (IS 1444:1989)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Length x Width</td>
<td></td>
<td></td>
<td>Length x Width</td>
<td></td>
</tr>
<tr>
<td>A0</td>
<td>1189 x 841</td>
<td></td>
<td>D0</td>
<td>1270 x 920</td>
<td></td>
</tr>
<tr>
<td>A1</td>
<td>841 x 594</td>
<td></td>
<td>D1</td>
<td>920 x 650</td>
<td></td>
</tr>
<tr>
<td>A2</td>
<td>594 x 420</td>
<td></td>
<td>D2</td>
<td>650 x 470</td>
<td></td>
</tr>
<tr>
<td>A3</td>
<td>420 x 297</td>
<td></td>
<td>D3</td>
<td>500 x 350</td>
<td></td>
</tr>
<tr>
<td>A4</td>
<td>297 x 210</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 1.2 Drawing board
Prerequisite For Engineering Drawing

Lead Grade Sheet

<table>
<thead>
<tr>
<th>Hard</th>
<th>Medium</th>
<th>Soft</th>
</tr>
</thead>
<tbody>
<tr>
<td>The hard leads in this group (left) are used where extreme accuracy is required, as on graphical computations and charts and diagrams. The softer leads in this group (right) are sometimes used for line work on engineering drawings, but their use is restricted because the lines are apt to be too light.</td>
<td>These grades are for general purpose work in technical drawing. The softer grades (right) are used for technical sketching, for lettering, arrowheads, and other free-hand work on mechanical drawings. The harder leads (left) are used for line work on machine drawings and architectural drawings.</td>
<td>These leads are too soft to be useful in mechanical drafting. Their use for such work results in smudged, rough lines that are hard to erase, and the lead must be sharpened continually. These grades are used for art work of various kinds, and for full-size details in architectural drawing.</td>
</tr>
</tbody>
</table>

Prerequisite For Engineering Drawing

Clamping screw

Clamping strap

Clamping mechanism

Steel bars

Scale

Scale screw

Bar plate

Scale plate
Prerequisite For Engineering Drawing

Drawing pin
Adhesive tape

Clip 2
Clip 3

0 setting of drafter

Needle point
Knee joint
Pencil point

Lead sticks
Compass preparation

Paper depth
Prerequisite For Engineering Drawing

Lettering

- Lettering means
  - Writing of titles, dimensions, notes and other important particulars

- Types
  - Single stroke letters
  - Double stroke letters

- Single Stroke
  - Thickness of the line of the letter should be such as is obtained in one stroke of the pencil.
  - Does not mean that the letter should be made in one stroke without lifting the pencil.
Basic Strokes

<table>
<thead>
<tr>
<th>Straight</th>
<th>Slanted</th>
<th>Horizontal</th>
<th>Curved</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓</td>
<td>_/</td>
<td>→</td>
<td>⬝</td>
</tr>
</tbody>
</table>

Examples

“T” letter

“A” letter

“B” letter

Height and Width of Letters

- BIS (SP 46: 2003) has recommended the heights of letters as:
  - 1.8 mm, 2.5 mm, 3.5 mm, 5 mm, 7 mm, 10 mm, 14 mm and 20 mm.
  - Large-sized letters are used for main titles and headings,
  - Medium-sized letters for subtitles and important notes and
  - Small-sized letters for dimensions and general notes.
  - The height-to-width ratio varies from letter to letter. Most of the letters follow the ratio 7 : 5 or 7 : 6.
Vertical Capital Letters and Numerical

Vertical Lowercase Letters
Double Stroke Lettering

• More thickness is given to single stroke letters, it is known as double stroke or gothic letters.

A B C D

Lettering Rules

1. Draw letters as simple as possible. Artistic or cursive lettering should be strictly avoided.

2. Draw letters symmetrical about the vertical axis or horizontal axis. Asymmetric letters like, F, R, Z, 4, etc., may be drawn as they are.

3. Round-off the sharp corners wherever necessary, e.g., D, P, S, etc.

4. Draw all letters legible and uniform.

5. The height of all the letters in one line should be the same.

6. Use single stroke vertical CAPITAL letters as much as possible.
“Engineering drawing” or “blueprint” uses **lines** to represent the **features** of an object.

Features of an object are **surface** (include **plane**) and **edge**.

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**Graphic Language in Engineering Drawing**

- **Surface**
- **Edge**

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**Lines**

<table>
<thead>
<tr>
<th>Line</th>
<th>Description</th>
<th>General applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Continuous thick or continuous wide</td>
<td>Visible outlines, visible edges; edges of screw threads, limits of length of full depth through holes and sections; contour lines of outlines in views; main representations in diagrams, maps, flow charts; system boundaries (structural steel)</td>
</tr>
<tr>
<td>B</td>
<td>Continuous thin (narrow), straight or curved</td>
<td>Imaginary lines of intersection; grids; dimension, extension, projection; representation lines; hatching, outlines of involved sections; most of letterheads, representation (lines of legend features); hatching of details; indicator or repetitive details</td>
</tr>
<tr>
<td>C</td>
<td>Continuous thin (narrow) thinhead</td>
<td>Lines of partial or interrupted views and sections, if the line is not a chain thin line</td>
</tr>
<tr>
<td>D</td>
<td>Continuous thin (narrow) with zigzag (right)</td>
<td>Long break line</td>
</tr>
<tr>
<td>E</td>
<td>Dashed thick (wide)</td>
<td>Line showing permissible of surface treatment</td>
</tr>
<tr>
<td>F</td>
<td>Dashed thin (narrow)</td>
<td>Hidden outlines; hidden edges</td>
</tr>
<tr>
<td>G</td>
<td>Chain thin, long-dashed dotted, chain thin</td>
<td>Centre line; lines of symmetry; trajectories; pitch circles of gears; pitch circle of holes, cutting planes</td>
</tr>
<tr>
<td>H</td>
<td>THICK, THIN, THICK</td>
<td>Cutting planes</td>
</tr>
<tr>
<td>I</td>
<td>Chain thin (narrow) with thick indicator at the ends and at changing of position</td>
<td>Indication of lines or surfaces to which a special requirement applies</td>
</tr>
<tr>
<td>J</td>
<td>Chain thick or long-dashed dotted (wide)</td>
<td>Outlines of adjacent parts; alternative and extreme positions of movable parts; Complementary lines; initial outlines prior to forming</td>
</tr>
<tr>
<td>K</td>
<td>Chain thin double-dashed or long-dashed, double-dotted (narrow)</td>
<td>Indication of lines or surfaces to which a special requirement applies</td>
</tr>
</tbody>
</table>

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**Lines**

- **Visible line**
  - Approx. width 0.6 mm (0.024")

- **Hidden line**
  - Approx. width 0.3 mm (0.012")

- **Section line**

- **Center line**
  - 1.0 mm (0.040")

- **Dimension line, Extension line**
  - 90.5°

- **Leaders**
  - 1.6 mm (0.06")

- **Cutting plane or Viewing plane lines**
  - 3.2 mm (0.13")

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**Diagram**

- (a)
- (b)
- (c)
- (d)
Dimensioning

BIS (SP 46: 2003) defines dimension as a numerical value expressed in appropriate units of measurement and indicated graphically on technical drawings with lines, symbols and notes.

The important aspects of dimensioning are as follows:

- Units of Measurement: The most convenient unit for length is millimeter. Angles are shown in degrees. Symbols are incorporated to indicate specific geometry wherever necessary.

  Dimensioning is often done by a set of elements, which includes
  - extension lines,
  - dimension lines,
  - leader lines,
  - arrowheads and
  - dimensions.

**Dimension line:** Dimension line is a thin continuous line. It is terminated by arrowheads touching the outlines, extension lines or centre lines.

**Extension lines:** An extension line is also a thin continuous line drawn in extension of an outline. It extends by about 3 mm beyond the dimension line.

**Arrowheads:** An arrowhead is placed at each end of a dimension line. Its pointed end touches an outline, an extension line or a center line. The size of an arrowhead should be proportional to the thickness of the outlines. The length of the arrowhead should be about three times its maximum width.

**Leader:** A leader or a pointer is a thin continuous line connecting a note or a dimension figure with the feature to which it applies.
• Dimension lines should be drawn at least 10 mm away from the outlines
• Smaller dimensions should be placed nearer the view and the larger further away so that extension lines do not cross dimension lines
• As far as possible, all the dimensions should be placed outside the views. Inside dimensions are preferred only if they are clearer and more easily readable

Arrowheads should ordinarily be drawn within the limits of the dimensioned feature. But when the space is too narrow, they may be placed outside.

Dimensions should be placed outside the views.

Each dimension should be given only once. No dimension should be redundant.
All the dimensions on a drawing must be shown using either Aligned System or Unidirectional System. Two systems be mixed on the same drawing.

**Aligned System:** Dimensions are placed perpendicular to the dimension line so that they may be read from the bottom or right-hand side of the drawing sheet. Dimensions are placed at the middle and above of the dimension lines.

**Unidirectional System:** Dimensions are placed in such a way that they can be read from the bottom edge of the drawing sheet. Dimension lines are broken near the middle for inserting the dimensions.

The unit should not be written after each dimension, but a note mentioning the unit should be placed below the drawing.

Figure shows various methods of dimensioning different sizes of circles

**Arc Radius:** An arc is dimensioned by its radius R by any one of the ways. Only one arrowhead with its point on the arc end of the dimension line is used.

Dimension lie of a radius should pass thorough the center of the arc. Mark the center with a small cross.
Do not repeat the same dimension in different views

Center line (axis) itself shall not be used as a dimension line with arrowheads as its ends

Center line (axis) itself shall not be used as a dimension line with arrowheads as its ends

Dimensions shall be given to visible lines and not to hidden lines

Overall dimension shall be placed outside the intermediate dimensions. i.e smaller dimensions shall be placed nearer the view and the larger farther away so that extension lines do not cross dimension lines
<table>
<thead>
<tr>
<th>CORRECT</th>
<th>INCORRECT</th>
<th>REASONS FOR INCORRECT</th>
</tr>
</thead>
</table>
| ![Correct Image](image1.png) | ![Incorrect Image](image2.png) | 1. Arrow head not proportionate.  
2. Hole dimension shown in figure. Leader line not ends horizontally.  
3. Dimension '40' is too close.  
4. Placing dimensions methods mix. Dimension '40' is according to aligned method. |
| ![Correct Image](image3.png) | ![Incorrect Image](image4.png) | 1. A key-way is shown with dotted line where the dimensions are placed.  
2. Leader line for the shaft diameter is drawn horizontal touching the boundary line. |
| ![Correct Image](image5.png) | ![Incorrect Image](image6.png) | 1. Dimensions are given form the mid-line of the object.  
2. Dimensions of holes are shown inside the figure.  
3. Dimensions are shown in vertical line.  
4. Smaller dimensions (2.5 mm) precedes the larger dimensions (30 mm).  
5. Fillet radius is not shown. |

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<table>
<thead>
<tr>
<th>(v)</th>
<th>Section overlap the dimension 21.</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image7.png" alt="Section Overlap" /></td>
<td>The outlines of the object are used as the extension lines.</td>
</tr>
</tbody>
</table>
| (vi) | 1. Smaller circle is designated with radius.  
2. Convention 'Ø' for diameter is placed after dimension.  
3. Leader has arrow and it is drawn horizontal. |
Summary

• Course Information
• Introduction to ED
• Drawing instruments
• Lettering
• Lines
• Dimensioning

**Reading task:** revise all above contents from the book.