

Course Name : Mechanical, Electrical, Chemical, Civil & Textile Program Group
 Course Code : AE/CE/CR/CS/CH/EE/EP/EU/ME/PG/PT/PS/FG/DC/TC/TX
 Semester : First
 Subject Title : Engineering Graphics
 Subject Code : 22002

1. RATIONALE

Engineering graphics is the language of engineers. The concepts of graphical language are used in expressing the ideas, conveying the instructions, which are used in carrying out the jobs on the sites, shop floor. It covers the knowledge and application of drawing instruments and also familiarizes the learner about Bureau of Indian standards related to engineering drawing. The curriculum aims at developing the ability to draw and read various engineering curves, projections and dimensioning styles. The course mainly focuses on use of drawing instruments, developing imagination and translating ideas into sketches. The course also helps to develop the idea of visualizing the actual object or part on the basis of drawings and blue prints. This preliminary course aims at building a foundation for the further courses related to engineering drawing and other allied courses in coming semesters.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- Prepare engineering drawing manually using prevailing drawing instruments.

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following **industry oriented** COs associated with the above mentioned competency:

- Draw geometrical figures and engineering curves.
- Draw the views of given object using principles of orthographic projection.
- Draw isometric views of given component or from orthographic projections.
- Use drawing codes, conventions and symbols as per IS SP-46 in engineering drawing.
- Draw free hand sketches of given engineering elements.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
L	T	P		Theory						Practical					
				Paper Hrs.	ESE		PA		Total	ESE		PA		Total	
					Max	Min	Max	Min		Max	Min	Max	Min	Max	Min
2	--	4	6	--	--	--	--	--	--	50@	20	50~	20	100	40

(**) marks should be awarded on the basis of internal end semester theory exam of 50 marks based on the specification table given in S. No. 9.

(~): For the courses having **ONLY** practical examination, the PA has two components under practical marks i.e. the assessment of practicals (seen in section 6) has a weightage of 60% (i.e. 30 marks) and micro-project assessment (seen in section 12) has a weightage of 40% (i.e. 20 marks). This is designed to facilitate attainment of COs holistically, as there is no theory ESE.

Legends: L-Lecture; T-Tutorial/Teacher Guided Theory Practice; P-Practical; C-Credit, ESE - End Semester Examination; PA - Progressive Assessment, #: No theory paper.

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

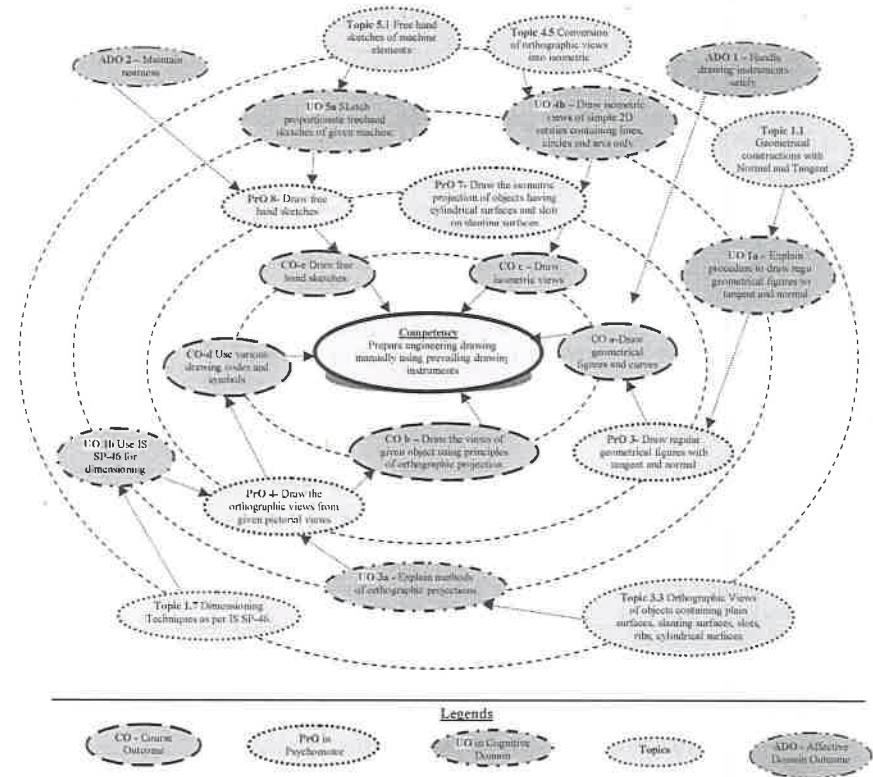


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency. Following practicals (except 1, 2, 3, 4, 31 and 32) are to be attempted on A2 drawing sheets.

S. No.	Practical Outcomes (PrOs) (Learning Outcomes in Psychomotor Domain)	Unit No.	Approx. Hrs. Required
1	Sketch Book		

S. No.	Practical Outcomes (PrOs) (Learning Outcomes in Psychomotor Domain)	Unit No.	Approx. Hrs. Required
1	Draw horizontal, vertical, 30 degree, 45 degree, 60 and 75 degrees lines, different types of lines, dimensioning styles using Set squares/ drafter.	I	02
2	Write alphabets and numerical (Vertical only)	I	02
3	Draw regular geometric constructions	I	02
4	Redraw the given figure	I	02
Sheet No. 1 (Three problems)			
5	Draw one figure showing dimensioning techniques. (Problem 1)	I	02
6	Draw one problem on redraw the figure. (Problem 2)	I	02
7	Draw one problem on loci of points - slider crank mechanism. (Problem 3)	I	02
Sheet No. 2 (Two problems)			
8	Draw Engineering Curves. (Problem 1)	II	02
9	Draw Engineering Curves. (Problem 1 continued)	II	02
10	Draw Engineering Curves. (Problem 2)	II	02
11	Draw Engineering Curves. (Problem 2 continued)	II	02
Sheet No. 3 (Two problems)			
12	Draw a problem on orthographic projections using first angle method of projection having plain and slanting surfaces. (Problem 1)	III	02
13	Draw problem on orthographic projections using first angle method of projection having plain and slanting surfaces. (Problem 1 continued)	III	02
14	Draw another problem on orthographic projections using first angle method of projection having plain and slanting surfaces. (Problem 2)	III	02
15	Draw another problem on orthographic projections using first angle method of projection having plain and slanting surfaces. (Problem 2 continued)	III	02
Sheet No. 4 (Two problems)			
16	Draw two problems on orthographic projections using first angle method of projection having cylindrical surfaces, ribs. (Problem 1)	III	02
17	Draw two problems on orthographic projections using first angle method of projection having cylindrical surfaces, ribs. (Problem 1 continued)	III	02
18	Draw two problems on orthographic projections using first angle method of projection having cylindrical surfaces, ribs. (Problem 2)	III	02
19	Draw two problems on orthographic projections using first angle method of projection having cylindrical surfaces, ribs. (Problem 2 continued)	III	02
Sheet No. 5 (Two problems)			
20	Draw two problems on Isometric view of simple objects having plain and slanting surface by using natural scale. (Problem 1)	IV	02
21	Draw two problems on Isometric view of simple objects having plain and slanting surface by using natural scale. (Problem 1 continued)	IV	02



S. No.	Practical Outcomes (PrOs) (Learning Outcomes in Psychomotor Domain)	Unit No.	Approx. Hrs. Required
22	Draw two problems on Isometric view of simple objects having plain and slanting surface by using natural scale. (Problem 2)	IV	02
23	Draw two problems on Isometric view of simple objects having plain and slanting surface by using natural scale. (Problem 2 continued)		
Sheet No. 6 (Two problems)			
24	Draw a problem on Isometric Projection of objects having cylindrical surface by using isometric scale. (Problem 1)	IV	02
25	Draw a problem on Isometric Projection of objects having cylindrical surface by using isometric scale. (Problem 1 continued)	IV	02
26	Draw a problem on Isometric Projection of objects having slot on slanting surface by using isometric scale. (Problem 2)	IV	02
27	Draw a problem on Isometric Projection of objects having slot on slanting surface by using isometric scale. (Problem 2 continued)	IV	02
Sheet No. 7 (Six problems)			
28	Draw free hand sketches/conventional representation of machine elements in sketch book such as thread profiles, nuts, bolts, studs, set screws, washers, Locking arrangements. (Problem 1,2)	V	02
29	Draw free hand sketches/conventional representation of machine elements in sketch book such as thread profiles, nuts, bolts, studs, set screws, washers, Locking arrangements. (Problem 3,4)	V	02
30	Draw free hand sketches/conventional representation of machine elements in sketch book such as thread profiles, nuts, bolts, studs, set screws, washers, Locking arrangements. (Problem 5,6)	V	02
Sketch Book (Two problems)			
31	Problem Based Learning: Given the 3D model of an object, student will try to imagine the three views and draw them in the sketch book. (Problem 1)	III, II, V	02
32	Problem Based Learning: Given the 3D model of an object, student will try to imagine the three views and draw them in the sketch book. (Problem 2)	III, II, V	02
Total			64

All practicals are to be performed.

Note

- A suggestive list of PrOs is given in the above table. more such PrOs can be added to attain the COs and competency.
- The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
1	Neatness, Cleanliness on drawing sheet	10
2	Uniformity in drawing and line work	10

S. No.	Performance Indicators	Weightage in %
3	Creating given drawing	40
4	Dimensioning the given drawing and writing text	20
5	Answer to sample questions	10
6	Submission of drawing in time	10
	Total	100

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

- Follow cleanliness and neatness.
- Follow ethics and standards.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	Exp. S.No.
1	Drawing Table with Drawing Board of Full Imperial/ A1 size.	All
2	Models of objects for orthographic / isometric projections	4,5,6,7
3	Models/ Charts of objects mentioned in unit no. 5	-
4	Set of various industrial drawings being used by industries.	All
5	Set of drawings sheets mentioned in section 6.0 could be developed by experienced teachers and made used available on the MSBTE portal to be used as reference/standards.	All
6	Drawing equipment's and instruments for class room teaching-large size: a. T-square or drafter (Drafting Machine) b. Set squares (45° and 30°- 60°) c. Protractor d. Drawing instrument box (containing set of compasses and dividers)	All
7	Interactive board with LCD overhead projector	All

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics is to be taught and assessed in order to develop UOs for achieving the COs to attain the identified competency:

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Basic elements of Drawing	1a. Prepare drawing using drawing instruments. 1b. Use IS SP-46 for dimensioning. 1c. Use different types of lines. 1d. Draw regular geometrical figures. 1e. Draw figures having tangency constructions.	1.1 Drawing Instruments and supporting material: method to use them with applications. 1.2 Standard sizes of drawing sheets (ISO-A series) 1.3 I.S. codes for planning and layout. 1.4 Letters and numbers (single stroke vertical) 1.5 Convention of lines and their applications. 1.6 Scale - reduced, enlarged and full size 1.7 Dimensioning techniques as per SP-46 (Latest edition) – types and applications of chain, parallel and coordinate dimensioning 1.8 Geometrical constructions.
Unit– II Engineering curves and Loci of Points	2a. Explain different engineering curves with areas of application. 2b. Draw different conic sections based on given situation. 2c. Draw involute and cycloidal curves based on given data. 2d. Draw helix and spiral curves from given data 2e. Plot Loci of points from given data.	2.1 Concept of focus, directrix, vertex and eccentricity. Conic sections. 2.2 Methods to draw an ellipse by Arcs of circle method and Concentric circles method. 2.3 Methods to draw a parabola by Directrix-Focus method and Rectangle method 2.4 Methods to draw a hyperbola by Directrix-Focus method. 2.5 Methods to draw involutes: circle and pentagon, 2.6 Methods to draw Cycloidal curve: cycloid, epicycloid and hypocycloid 2.7 Methods to draw Helix and Archimedean spiral. 2.8 Loci of points on Single slider crank mechanism with given specifications.
Unit– III Orthographic projections	3a. Explain methods of Orthographic Projections. 3b. Draw orthographic views of given simple 2D entities containing lines, circles and arcs only. 3c. Draw the orthographic views from given pictorial views.	3.1 Projections-orthographic, perspective, isometric and oblique: concept and applications.(No question to be asked in examination) 3.2 Orthographic projection, First angle and Third angle method, their symbols. 3.3 Conversion of pictorial view into Orthographic Views – object containing plain surfaces, slanting surfaces, slots, ribs, cylindrical surfaces. (use First Angle Projection Method Only)
Unit– IV Isometric projections	4a. Prepare isometric scale. 4b. Draw isometric views of given simple 2D entities containing lines,	4.1 Isometric projection. 4.2 Isometric scale and Natural Scale. 4.3 Isometric view and isometric projection. 4.4 Illustrative problems related to simple



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	circles and arcs only. 4c. Interpret the given orthographic views. 4d. Draw Isometric views from given orthographic views.	objects having plain, slanting, cylindrical surfaces and slots on slanting surfaces. 4.5 Conversion of orthographic views into isometric View/projection.
Unit– V Free Hand Sketches of engineering elements	5a. Sketch proportionate freehand sketches of given machine elements. 5b. Select proper fasteners and locking arrangement for given situation.	5.1 Free hand sketches of machine elements: Thread profiles, nuts, bolts, studs, set screws, washers, Locking arrangements. (For branches other than mechanical Engineering, the teacher should select branch specific elements for free hand sketching)

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' of Bloom's 'Cognitive Domain Taxonomy'

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER (INTERNAL) DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Principles of Drawing	04	-	02	04	06
II	Engineering curves and Loci of Points.	06	-	02	04	06
III	Orthographic projections	06	-	02	08	10
IV	Isometric projections	08	02	07	07	16
V	Free Hand Sketches of m/c elements	08	02	02	08	12
Total		32	4	15	31	50

Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of LOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

This specification table also provides a general guideline for teachers to frame internal end semester practical theory exam paper which students have to undertake on the drawing sheet.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related co-curricular activities which can be undertaken to accelerate the attainment of the various outcomes in this course:

- Student should maintain a separate A3 size sketch book which will be the part of term work and submit it along with drawing sheets. Following assignment should be drawn in the sketch book
 - Single stroke vertical Letters and Numbers.

- Type of lines.
 - Redraw the figures (any one).
 - Engineering Curves. One problem for each type of curve.
 - Orthographic projections. Minimum 5 problems.
 - Isometric Projections/Views. Minimum 5 problems.
 - Free hand sketches. All types of machine elements mentioned in Unit no-5.
 - Note- Problems on sheet and in the sketch book should be different.
- Students should collect Maps, Production drawings, Building Drawings, Layouts from nearby workshops/industries/builders/contractors and try to list
 - Types of lines used
 - Lettering styles used
 - Dimension styles used
 - IS code referred
 - List the shapes and curves you are observing around you in real life with name of place and item. (For Ex. ellipse, parabola, hyperbola, cycloid, epicycloids, hypocycloid, involute, spiral helix).
 - Take one circular shape. Assume one point on circumference and mark it. Roll that shape on flat and circular surface. Observe the path of the point and try to correlate with the theory taught in the class
 - Take circular and pentagonal shape and wrap a thread over the periphery, now unwrap this thread and observe the locus of the end of the thread and try to correlate with the theory taught in the class
 - Each student should explain at least one problem for construction and method of drawing in sheet to all batch colleagues. Teacher will assign the problem of particular sheet to be explained to each student batch.
 - Each student will assess at least one sheet of other students (May be a group of 5-6 students identified by teacher can be taken) and will note down the mistakes committed by them. Student will also guide the students for correcting the mistakes, if any.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- Massive open online courses (MOOCs) may be used to teach various topics/sub topics.
- 'L' in section No. 4 does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
- About 15-20% of the topics/sub-topics which is relatively simpler or descriptive in nature is to be given to the students for self-directed learning and assess the development of the COs through classroom presentations (see implementation guideline for details).
- With respect to item No.10, teachers need to ensure to create opportunities and provisions for co-curricular activities.
- Guide student(s) in undertaking micro-projects.
- Guide student(s) in fixing the sheet and mini drafter on drawing board.
- Show video/animation films to explain orthographic and Isometric projection.
- Demonstrate first and third angle method using model
- Use charts and industrial drawing/drawing sheets developed by experienced faculty to teach standard symbols and current industrial/teaching practices



12. SUGGESTED MICRO PROJECTS

Only one micro-project is planned to be undertaken by a student assigned to him/her in the beginning of the semester. S/he ought to submit it by the end of the semester to develop the industry oriented COs. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs, and ADOs. The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than **16 (sixteen) student engagement hours** during the course.

In the first four semesters, the micro-project could be group-based. However, in higher semesters, it should be individually undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. A suggestive list is given here. Similar micro-projects could be added by the concerned faculty:

- Helical springs:** Each batch will collect 5 open coil and closed coil helical springs of various sizes. Each student will measure the significant parameters of one spring and draw corresponding helix curve in his sketch book.
- Flat coil or spiral springs:** Each batch will collect 10 spiral springs of various sizes. Each student will measure the significant parameters of one spring and draw corresponding helix curve in his sketch book.
- Isometric views:** Each student of the batch will try to collect at least one production drawings/ construction drawings/plumbing drawings from local workshops/builders /electrical and mechanical contractors and try to generate isometric views from the orthographic views given in the drawings.
- Isometric views:** Each student of a batch will select a household/industrial real item and will draw its isometric view in the sketch book.
- Isometric and orthographic views:** Each batch will collect a single point cutting tool from workshop and draw its Isometric and orthographic views with a ten times enlarged scale. In carpentry shop each batch will try to make wooden model from these views.
- Isometric views:** The teacher will assign one set of orthographic projections and ask the student to develop 3D thermocol models of the same.
- Involute curves:** Each batch will try to develop cardboard/thermocol working models which can generate involute curve of any regular geometrical shape.
- Cycloidal curves:** Each batch will collect 3 different sizes bicycle tyres and compare the locus of tube air valve by rolling them on flat road.
- Conic curves:** Each batch will go to institute's play ground and one student standing on the boundary throws a ball to the wicket keeper who is 30 meters away from the thrower and the ball has reached a maximum height of 20 meters from the ground, draw the path of the ball and identify the type of conic curve it has traced in air.
- Involute and Cycloidal curves:** Each batch will collect one Involute and one cycloidal tooth profile spur gear and find out the Involute function.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1.	Engineering Drawing Practice for Schools and Colleges IS: SP-46	Bureau of Indian Standards.	BIS, Government of India, Third Reprint, October 1998; ISBN: 81-7061-091-2

S. No.	Title of Book	Author	Publication
2.	Engineering Drawing	Bhatt, N.D.	Charotar Publishing House, Anand, Gujarat 2010; ISBN: 978-93-80358-17-8
3.	Machine Drawing	Bhatt, N.D.; Panchal, V. M	Charotar Publishing House, Anand, Gujarat 2010; ISBN: 978-93-80358-11-6
4.	Engineering Drawing	Jolhe, D.A.	Tata McGraw Hill Edu. New Delhi, 2010, ISBN: 978-0-07-064837-1
5.	Engineering Drawing	Dhawan, R. K.	S. Chand and Company New Delhi, ISBN: 81-219-1431-0
6.	Engineering Drawing	Shaha, P. J.	S. Chand and Company, New Delhi, 2008, ISBN: 81-219-2964-4

14. SOFTWARE/LEARNING WEBSITES

- <https://www.youtube.com/watch?v=TJ4jGyD-WCw>
- https://www.youtube.com/watch?v=dmt6_n7Sgcg
- https://www.youtube.com/watch?v=_MQScnLXL0M
- <https://www.youtube.com/watch?v=3WXPanCq9LI>
- <https://www.youtube.com/watch?v=fvjk7PlxAuo>
- <http://www.me.umn.edu/courses/me2011/handouts/engg%20graphics.pdf>
- <https://www.machinedesignonline.com>

