MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION (MSBTE)

I – Scheme
II – Semester Course Curriculum

Course Title: **Engineering Drawing** (AE, ME, PT)
(Course Code: ....)

Diploma programme in which this course is offered	Semester in which offered
Automobile Engineering, Mechanical Engineering, Production Technology	Second

1. RATIONALE

Engineering drawing is the language of engineers. The concepts of drawing language are used in visualizing the situation, materializing the ideas, conveying the instructions which are used in carrying out engineering jobs. The course aims at developing the ability to draw and read projections of lines/planes/solids and develops imagination and translating skills in drawing orthographic sectional, missing views and auxiliary views of common engineering components. Knowledge of conventional representation of various joints helps to read and draw various production drawings. This course also aims at building foundation for further courses related to engineering drawing and other allied courses in coming semesters.

2. COMPETENCY

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

- **Prepare engineering drawings using prevailing drawing standards and 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:

a. Draw projections of 2D and 3D standard regular entities.
b. Draw sectional views of objects.
c. Draw orthographic sectional and missing views.
d. Draw auxiliary views of objects.
e. Use various drawing codes, conventions and symbols as per IS SP-46.
f. Draw free hand sketches of given engineering elements.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
3	-	4	7	70	30*	25	25	150

(*): *Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain LOs required for the attainment of the COs***.**

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment*

4. COURSE MAP (with sample COs, Learning Outcomes i.e. LOs 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.

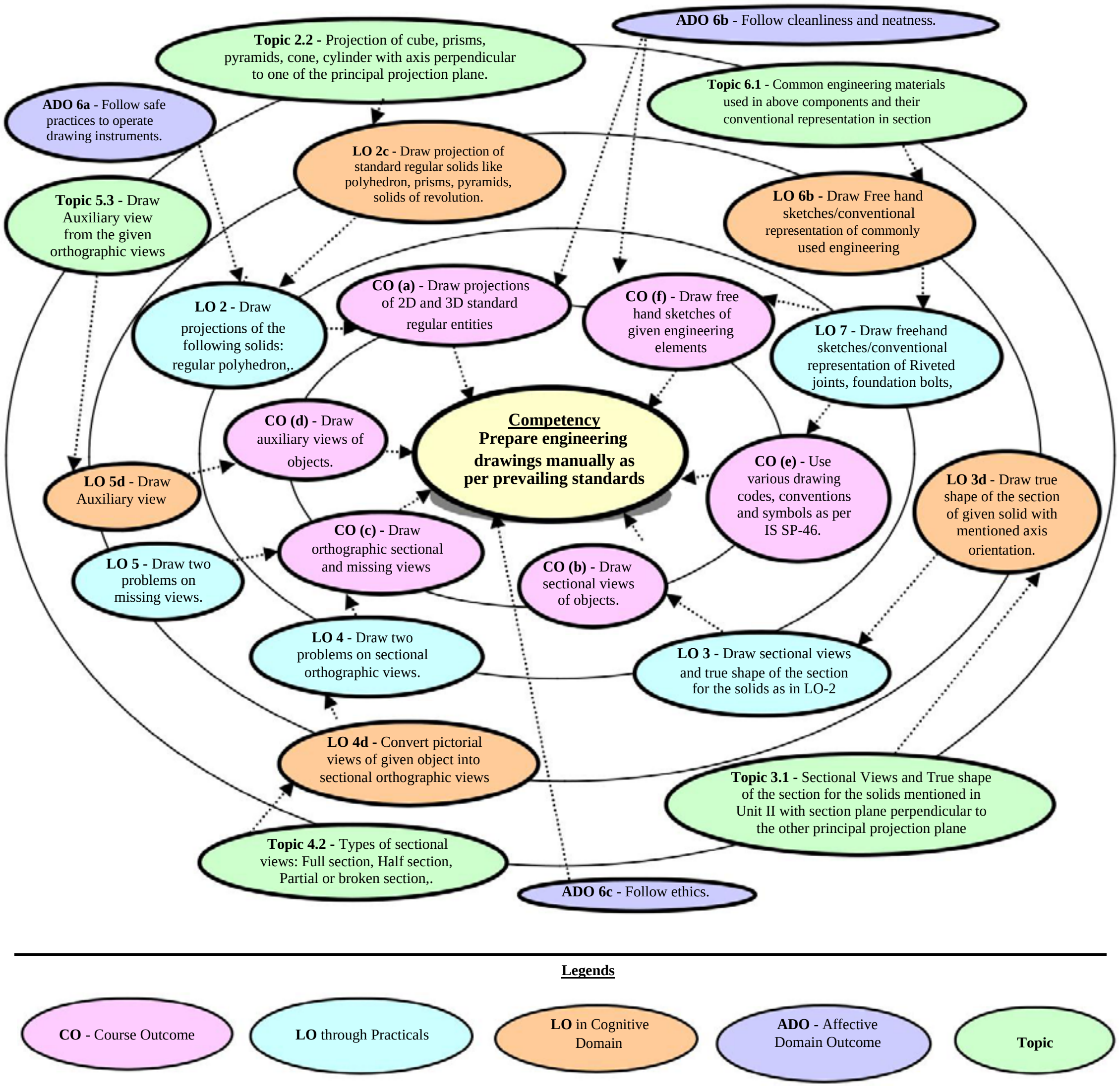

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals/exercises/tutorials in this section are psychomotor domain LOs (i.e.sub-components of the COs), to be developed and assessed in the student to lead to the attainment of the competency.

S. No.	**Practical Exercises** (Learning Outcomes in Psychomotor Domain)	**Unit No.**	**Approx. Hrs. Required**
1.	Draw two problems on projection of straight lines Part I	I	02*
2.	Draw two problems on projection of planes Part II	I	02
3.	Draw projections of Regular polyhedron. Part I	II	02*
4.	Draw projections of Regular polyhedron. Part II	II	02
5.	Draw projections of Regular prisms. Part III	II	02
6.	Draw projections of Regular pyramids Part. IV	II	02
7.	Draw projections of Regular solids of revolution. Part V	II	02
8.	Draw sectional views and true shape of the section for the solids mentioned in S. No.3-6. Part I	III	02*
9.	Draw sectional views and true shape of the section for the solids mentioned in S. No.3-6. Part II	III	02
10.	Draw sectional views and true shape of the section for the solids mentioned in S. No.3-6. Part III	III	02
11.	Draw sectional views and true shape of the section for the solids mentioned in S. No.3-6. Part IV	III	02
12.	Draw sectional views and true shape of the section for the solids mentioned in S. No.3-6. Part V	III	02
13.	Draw two problems on sectional orthographic views. Part I	IV	02*
14.	Draw two problems on sectional orthographic views. Part II	IV	02
15.	Draw two problems on sectional orthographic views. Part III	IV	02
16.	Draw two problems on sectional orthographic views. Part IV	IV	02
17.	Draw two problems on missing views. Part I	V	02*
18.	Draw two problems on missing views. Part II	V	02
19.	Draw two problems on missing views. Part III	V	02
20.	Draw two problems on missing views. Part IV	V	02
21.	Draw two problems on missing views. Part V	V	02
22.	Draw two problems on missing views. Part VI	V	02
23.	Draw auxiliary view from the given orthographic views - one problem. Part I	V	02
24.	Draw auxiliary view from the given orthographic views - one problem. Part II	V	02
25.	Draw auxiliary view from the given orthographic views - one problem. Part III	V	02
26.	Draw principal view from the given auxiliary view and other principal view - one problem. Part IV	V	02
27.	Draw principal view from the given auxiliary view and other principal view - one problem. Part V	V	02
28.	Draw principal view from the given auxiliary view and other principal view - one problem. Part VI	V	02
29.	Draw free hand sketches/conventional representation of:	VI	02*

S. No.	**Practical Exercises** (Learning Outcomes in Psychomotor Domain)	Unit No.	Approx. Hrs. Required
	i. Rivet heads(1 sheet, at least 10 sketches/conventional representations). ii. Riveted joints: Lap Joint – Single and Double Riveted.		
30.	Draw free hand sketches/conventional representation of: i. Butt Joint – Single Strap, Double Strap. ii. Foundation bolts: Eye and Lewis.	VI	02
31.	Draw free hand sketches/conventional representation of: i. Couplings: Muff, Protected Flange and Flexible Flange. ii. Pulleys: Rope and V-Belt.	VI	02
32.	Draw free hand sketches/conventional representation of: i. Welding joints. ii. Common engineering materials used in practice and their conventional representation in section.	VI	02
	Total		**64**

Note

i. *A suggestive list of practical LOs is given in the above table, more such practical LOs can be added to attain the COs and competency. A judicial mix of minimum 24 or more practical LOs/tutorials need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. *Hence, the 'Process' and 'Product' related skills associated with each LO of the laboratory/workshop/field work are 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
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**

Additionally, the following affective domain LOs (social skills/attitudes), are also important constituents of the competency which can be best developed through the above mentioned laboratory/field based experiences:

a. Follow safe practices to operate drawing instruments.
b. Follow cleanliness and neatness.
c. Follow ethics and standards.

The development of the attitude related LOs of Krathwohl's 'Affective Domain Taxonomy', the achievement level may reach:

- '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 administrators.

S. No.	Equipment Name with Broad Specifications	Exp. No.
1	Drawing Table with Drawing Board of A1 or full imperial size	All
2	Drawing sheet of A2 or half imperial size	All
3	Models of various types of solids	2
4	Models of cut section of various solids	3
5	Models of cut sections of objects	4
6	Models of Mechanical Components	5
7	Models of objects with inclined surfaces	6
8	Specimen library of various rivet heads, foundation bolts, welding joints, valves and pipe fittings	7
9	Set of various industrial drawings being used by industries	All
10	Set of drawings sheets mentioned in section 6.0 could be developed by experienced teachers and made available on the MSBTE portal to be used as reference/standards	All
11	Drawing equipment's and instruments for class room teaching-large size: a. T-square or drafter (Drafting Machine) b. Set squares (45^0 and 30^0- 60^0) c. Protractor d. Drawing instrument box (containing set of compasses and dividers)	All
12	Interactive board with LCD overhead projector	All

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to develop LOs in cognitive domain for achieving the COs to attain the identified competency.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Projection of straight lines and planes	1a. Classify various positions of lines with respect to projection planes. 1b. Draw projection of lines in different positions based on given situation. 1c. Classify various types of planes according to orientations. 1d. Draw projection of planes with different orientations based on given situation.	1.1 Projection of straight lines with following positions: a) Parallel to both the planes. b) Perpendicular to one plane. c) Inclined to one plane and parallel to the other. d) Inclined to both the planes. 1.2 Traces of a Line. 1.3 Projection of Planes with following orientations: i. Plane parallel to one principal plane and perpendicular to the other. ii. Plane inclined to one principal plane and perpendicular to the other.
Unit– II Projection	2a. Classify various types of solids.	2.1 Types of Solids 2.2 Projection of the following solids:

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
of solids	2b. Explain orientation of axis with respect to projection planes. 2c. Draw projection of given standard regular solids like polyhedron, prisms, pyramids, solids of revolution.	a) Regular Polyhedron – Tetrahedron, Hexahedron (cube) b) Regular prisms and Pyramids – Triangular, Square, Pentagonal, Hexagonal c) Regular solids of Revolution – Cylinder, Cone, Sphere. **With Axis**: i. Perpendicular to one of the principal projection plane. ii. Inclined to one of the principal plane and parallel to the other. iii. Parallel to both principal planes
Unit– III Sections of solids	3a. Describe cutting planes and their orientation with respect to given solid and projection planes. 3b. Explain significance of sectional view and true shape. 3c. Draw sectional view of given solid. 3d. Draw true shape of the section of given solid with mentioned axis orientation.	3.1 Sectional Views and True shape of the section for the solids mentioned in Unit II with section plane in following positions: i parallel to one of the principal projection plane ii inclined to one and perpendicular to the other principal projection plane *Note: Position of solid is restricted to the following:* i. Axis parallel to both principal projection planes ii. Axis perpendicular to one and parallel to the other principal projection plane
Unit– IV Sectional orthographic views	4a. Classify various types of sectional views. 4b. Explain sectioning and hatching conventions. 4c. Convert pictorial views of given object into sectional orthographic views. 4d. Interpret the given drawing.	4.1 Cutting plane line 4.2 Types of sectional views: Full section, Half section, Partial or broken section, Revolved section, Removed section, offset section, Aligned section. 4.3 Sectioning conventions 4.4 Hatching or section lines 4.5 Conversion of pictorial views into sectional orthographic views
Unit– V Missing and Auxiliary views	5a. Interpret the given views. 5b. Draw the missing view from given situation. 5c. Interpret given Auxiliary view 5d. Draw Auxiliary view based on given situation.	5.1 Draw Missing lines and views from the given orthographic views 5.2 Auxiliary planes and views 5.3 Draw Auxiliary view from the given orthographic views 5.4 Complete the partial view from the given auxiliary and other principal view
Unit VI	6a. Identify various	6.1 Draw Free hand sketches/conventional

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Free Hand sketches/conventional representation	engineering components and their materials in the given sectional view. 6b. Draw Free hand sketches/conventional representation of given engineering components.	representation of: i Rivet heads ii Riveted joints: Lap Joint – Single and Double Riveted, Butt Joint – Single strap, Double Strap iii Foundation bolts: Eye and Lewis iv Couplings: Muff, Protected Flange and Flexible Flange v Pulleys: Rope and V-Belt vi Welding joints 6.2 Common engineering materials used in above components and their conventional representation in section.

***Note**: To attain the COs and competency, above listed Learning Outcomes (LOs) need to be undertaken to achieve the 'Application Level' of Bloom's 'Cognitive Domain Taxonomy'.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Projection of straight Lines and Planes	10	-	02	08	10
II	Projection of solids	06	-	02	10	12
III	Section of solids	08	-	02	10	12
IV	Sectional orthographic views	08	-	02	10	12
V	Missing and Auxiliary views	12	02	04	12	18
VI	Free hand/conventional representation	04	04	02	-	06
Total		**48**	**06**	**14**	**50**	**70**

***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.*

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:

a. 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
   i. Minimum 5 problems each on Unit No I to VI.
   ii. Free hand sketches. All types of machine elements mentioned in Unit no-VI.
   iii. Note- Problems on sheet and in the sketch book should be different.
b. Students should collect Production drawings, Layouts from nearby workshops/industries and try visualize the part from the given views.

c. 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/assignment to be explained to each student batch.
d. 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:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item 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.
c. 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 LOs/COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Show video/animation films to explain sectional orthographic and missing views and other topics.
g. Use charts and industrial drawing/drawing sheets developed by experienced faculty to teach standard symbols and current industrial/teaching practices.
h. Assign different types of micro projects.
i. Use wooden models to explain the problems.
j. Show the actual parts / models of machine elements mentioned in Unit VI.
k. Use Computer Aided Instructional software for teaching various concepts.

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 practicals, cognitive domain and affective domain LOs. 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:

a. **Wood/Thermocol Related Jobs:** Students should use the wooden/thermocol models and verify the correctness of views drawn in the problems solved in the sketch book.

b. **Production drawings:** Each student of the batch should collect at least one production drawings from local workshops or industry and list various types of sections used in the drawings.
c. **Production drawings:** Each student should be given 10 problems in which two views of the objects are given with missing lines. Student should identify the missing lines and complete the views.
d. **Thermocol Models:** The teacher will assign one set of orthographic views/auxiliary views and ask the student to develop 3D thermocol models of the same.
e. Students should collect samples / catalogues of the standard mechanical components available in the market.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1.	Engineering Drawing	Bhatt, N.D.	Charotar Publishing House Pvt. Anand, Gujarat Ltd.; ISBN No. 978-93-80358-55-0
3.	Machine Drawing	Bhatt, N.D.; Panchal, V. M	Charotar Publishing House Pvt. Ltd. Anand, Gujarat, ISBN No. 978-93-80358-69-7
4.	Engineering Drawing	Narayana, K.L. ; Kannaiah, P.	Scitech Publications India Pvt. Ltd. ISBN No. 978-81-8371-422-8
5.	Machine Drawing	Singh, Ajeet	Tata McGraw Hill Education, New Delhi ISBN No.: 0 -07-065992-3
6.	Engineering Drawing	Agrawal, Basant; Agrawal, C. M.	Tata McGraw Hill Education, New Delhi ISBN No. 10: 0 – 07 -066863 - 9

14. SOFTWARE/LEARNING WEBSITES

a. http://www.youtube.com/watch?v=o1YPja2wCYQ
b. http://www.youtube.com/watch?v=9AGD4tihjCg&feature=plcp
c. http://www.youtube.com/watch?v=n65NU32inOU
d. http://www.youtube.com/watch?v=tyRVsSsNiUQ
e. http://www.youtube.com/watch?v=_M5eYB6056M
f. http://www.youtube.com/watch?v=UyROI-bAMu4
g. http://www.youtube.com/watch?v=eix8xbqb93s
h. http://www.youtube.com/watch?v=kWOl6ttDTBc
i. http://www.youtube.com/watch?v=gJbrO2jtoa8&feature=related
j. http://www.youtube.com/watch?v=PXgkBadGHEE
k. Engineering Graphics & Drawing v 1.0 from Cognifront