GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-I

Course Title: Mechanical Drawing and Drafting
(Course Code: 1316501)

Diploma programme in which this course is offered	Semester in which offered
Mechanical Engineering (CAD CAM)	First

1. RATIONALE

Mechanical drawing and drafting is a way of communication for engineers. It is a graphical language that essential for communicating design ideas and technical information to engineers in industry and other professionals throughout the design process. The purpose of a mechanical drawing and drafting is to clearly and accurately capture all geometric features of a product or component so that a manufacturer or engineer can produce the required item. This course aims at development of fundamental understanding and application of drawing and drafting so as to develop the ability to prepare, read and interpret drawings correctly and make aware of drafting practices, symbols, codes, norms and standards generally used in industries. It covers knowledge & application of drawing instruments & also familiarizes the learner about codified symbols and principles of technical drawing as per BIS (Bureau of Indian Standards) and ASME (American Society of Mechanical Engineers) standards.

2. COMPETENCY

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

- **Draw various mechanical component using codes, norms and standards.**
- **Interpret basic engineering drawings for various planning, manufacturing activities and inspection.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a) Use scales, drawing standards and drafting instruments as per BIS codes.
b) Construct engineering curves as per given dimensions.
c) Draw orthographic and sectional orthographic views from isometric views of simple objects and vice versa.
d) Apply Geometric Dimensioning and Tolerancing (GD&T) to machine parts in a manner that complies with the ASME Y14.5-2009 standard.
e) Prepare assembly and detail drawing of various mechanical components.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	4	5	30*	70	25	25	150

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

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

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. These PrOs need to be attained to achieve COs.

Sheet No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	**Use of Drawing Instruments:** Draw following as per I.S. 1a. Draw different types of lines. 1b. Draw simple drawing using various dimensioning systems. 1c. Illustrate dimensioning of circle, arc, angle, square bar, hexagonal bar, cylinder & sphere through figures. 1d. Draw 1st and 3rd angle orthographic projection symbols. 1e. Draw a typical Title block. 1f. Draw simple objects using reduced and enlarged scales.	I & II	06
2	**Engineering Curves (Conic Sections):** 2a. Construct ellipse using concentric circle method, four center method, arc of circle method, rectangle method, oblong method and eccentricity method. (four problems) 2b. Construct parabola using rectangular method, parallelogram method, tangent method and eccentricity method. (two problems) 2c. Construct hyperbola using rectangular method, oblique method and eccentricity method. (two problems)	III	06
3	**Surface Development:** Draw development of surface - 8 problems	IV	06
4	**Orthographic Projections and sectional views:** Draw Orthographic projections and sectional views of different objects (three views of each object) (Four problems one view of each problem must be sectional view).	V	08
5	**Isometric Projections:**	VI	08

Sheet No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	Draw isometric drawing from given orthographic views. (8 problems). 4 problems should be L, I, T and C sections.		
6	**Details:** Draw the details of all parts for the assembly assigned and sketched as student activity. (One problem)	IX	8
7	**Assembly:** Draw the assembly of all parts assigned by faculty. This includes minimum one sectional view and also prepare BOM. (One problem)	IX	8
8	**Production Drawing:** Draw the production drawing of simple machine components assigned by faculty. This includes Geometric & Dimensional Tolerances (GD&T), Surface Roughness Symbols, Open Dimensional Tolerances, Notes, etc., (One problem)	VIII	6
9	**Mechanical Symbols (Prepare only in sketch book)** *Draw following symbols & its interpretation:* Drafting Symbols (Machining, threading, dowels, pins, ribs, bearings, heat treatment conditions, surface conditions, assembly notes), Welding Symbols (as per BIS-813 / ASME, primary symbols & supplementary symbols), Piping Symbols (Pipe line symbol as per passing fluid, air, gas, water etc. and Piping fitting symbols.)	VII	-
	Total		**56**

Note

i. *Note: The teacher should demonstrate –*
   - *Use of drawing instruments.*
   - *Planning and layout of drawing sheet as per IS code.*
   - *Scaling technique.*

ii. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

iii. *Teachers should encourage students for optimum use of drawing sheet space. Further, instruct them to use both sides of a drawing sheet. For example, draw sheet number 2 on back side of sheet number 1, 4 on back of 3, and likewise.*

iv. *First angle orthographic projection and IS codes (Engineering Drawing Practices for School and Colleges SP 46:2003) should be followed wherever applicable.*

v. *The dimensions of line, axes, distances, angle, side of polygon, diameter, etc. must be varied for each student in batch so that each student will have same problems, but with different dimensions.*

vi. *The sketchbook should contain data related to all problems, solutions of all problems and student activities performed. Students' activities are compulsory to be performed.*
vii. *A hand out containing applicable standards from IS codes including title block as per IS standard should be given to each student by concerned teacher.*
viii. *For 25 marks Practical Marks ESE, students are to be assessed for competencies achieved. Students are to be given data for practical ESE to prepare drawings.*

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.

Sr.	Sample Performance Indicators for the PrOs	Weightage %
1	Drawing planning, layout and scale (for optimum use of drawing sheet)	20
2	Use of appropriate instruments, lines, dimensioning & annotations	30
3	Accuracy and Neatness of drawing	15
4	Timely submission of completed drawing sheet	15
5	Answering viva voce questions	20
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to user in uniformity of practicals in all institutions across the state.

Sr.	Equipment Name with Broad Specifications	PrO. No.
1	Drawing instruments for class room teaching (Large Size).	1 to 9
2	Models of various objects	3,4,5,6,7
3	Drawing Board (B2) & Mini Drafter.	All
4	Other Instruments: T-Square, Set square (45˚ and 30˚-60˚), Roller Scale, Protector, Drawing Compass, Dividers, Drawing Pencils (Clutch Pencil with H & 2H Lead), Lead Box (H & 2H – 0.5 or 0.7 mm) Circle Master, French Curves, Stencils (8-6-4 mm, All in One), Eraser, Drawing sheets, Drawing Pins/Clips, Sheet Container and Drawing instrument box.	All
5	Set of various drawings being used by industries/developed by experienced teachers.	6,7,8
6	Interactive board with LCD overhead projector	All

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member.
b) Follow safety practices
c) Follow ethical practices.

d) Maintain cleanliness
e) Practice environment friendly methods and processes. (Environment related)

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I **Engineering Drawing Aids, Planning Layout and Scaling of Drawing**	1a. Use of drawing instruments effectively. 1b. Follow and apply standard practice as per B.I.S. for planning and layout. 1c. Choose appropriate scale factor for the drawing as per the given situation.	1.1 Drawing instruments and materials. • Instruments-types, specifications, method to use them and applications. • Pencils-grades, papers-grades, applications, types of points and applications. • Other materials-types and applications. 1.2 I.S. cods for planning and layout.
Unit – II **Lines, Lettering and Dimensioning**	2a. Write annotations on the given drawing where ever necessary. 2b. Choose appropriate line and dimensioning style for given entity.	2.1 Different types of lines. 2.2 Lettering. 2.3 Dimensioning methods. • Aligned and unidirectional • Unilateral with chain, parallel, progressive and combined dimensioning.
Unit-III **Engineering Curves**	3a. Draw engineering curves with proficiency as per given dimensions.	3.1 Conic sections. a) Concept and understanding of focus, directrix, vertex and eccentricity and drawing of conic sections. b) Using various methods, understand construction and application of : • Ellipse • Parabola • Hyperbola

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit-IV **Development of Surface**	Develop the lateral surface of given Solid.	4.1 Types and dimensional specifications of solids (prism, pyramid, cylinder and cone) (only initial position of solid without any inclination with HP and VP). 4.2 Introduction to cutting planes / section planes, positions of the cutting plane (HCP, VCP, PCP, AVP &AIP) w.r.t solids. (no need to draw sectional view) 4.3 Development of surfaces of solids - Prism and pyramid - Cylinder & Cone
Unit-V **Orthographic Projection and sectional views**	5a. Draw the orthographic views of objects containing lines, circles and arc geometry. 5b. Interpret given orthographic views to imagine the shape of the component. 5c. Draw sectional orthographic views of an object. 5d. Interpretation of sectional orthographic views.	5.1 Types of projections-orthographic, perspective, isometric and oblique: concept and applications. 5.2 Various term associated with orthographic projections. • Theory of projection. • Methods of projection. • Orthographic projection. • Planes of projection. 5.3 Need of sections, section lines &cutting plane, rules for sectioning and section lines 5.4 Types and application of sections- full, half, revolved, removed, partial, off-set, aligned, etc. 5.5 Conversion of simple pictorial views into Orthographic and sectional views. Illustrative problems on orthographic projection. 5.6 B.I.S. code of practice.
Unit-VI **Isometric Projection**	Draw the isometric view from orthographic views of object/s containing lines, circles, arcs and slant surfaces.	6.1 Isometric axis, lines and planes. 6.2 Isometric scales, isometric projection and isometric drawing. 6.3 Simple shapes like L-section, I-section, T-section, C-section, etc. 6.5 Illustrative problems limited to objects Containing lines, circles and arcs shape only.
Unit-VII **Mechanical Drafting Symbols**	Use & interpret mechanical drafting symbols.	7.1 Machining symbol, Roughness symbol, Grade Number, Roughness value 7.2 Drafting and Geometric symbol, Welding Symbols (as per BIS-813 / ASME, primary symbols & supplementary symbols.) 7.3 Piping Symbols (Pipe line symbol as per passing fluid, air, gas, water etc. and Piping fitting symbols.)

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
		7.4 Demonstration of above symbol in production drawing.
Unit-VIII **System of Geometric Dimensioning and Tolerancing (GD&T)**	Use & interpret Geometric & Dimensioning Tolerances (GD&T) in production drawing.	8.1 Difference between dimensional tolerance & geometric tolerance. Limits & Fits–Introduction, need & applications. 8.2 Abbreviations & designations for shaft, holes and grades, determinations of deviation, limit, tolerance and fits, shaft basis and hole basis system & selection of shaft & hole pair as per standard tolerance of grades. 8.3 Selection of appropriate shaft / hole for a given condition, calculation of tolerances & deviations for a fit according to application of mating parts. 8.4 Geometric Tolerances – Introduction, symbols, representation, meaning of each element of tolerance frame and application in industrial drawing. *(Faculty should demonstrate & discuss moderate production drawing for better understanding of topic)*
Unit-IX **Details & Assembly**	9a. Prepare and interpret detail and assembly drawing. 9b. Workout bill of material (BOM) from a given drawing.	9.1 Importance and difference of these drawings. 9.2 Detail drawing from given assembly. 9.3 Assembly drawings from given details and prepare BOM.

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	**Engineering drawing aids, planning, layout and scaling of drawing**	**00**	**04**	**00**	**02**	**06**
II	**Lines, lettering and dimensioning**	**00**	**02**	**02**	**00**	**04**
III	**Engineering curves**	**06**	**02**	**00**	**04**	**06**
IV	**Development of Surfaces**	**06**	**00**	**02**	**06**	**08**
V	**Orthographic projections and sectional views**	**08**	**00**	**02**	**08**	**10**
VI	**Isometric projections**	**08**	**00**	**02**	**08**	**10**
VII	**Mechanical symbols**	**04**	**04**	**04**	**00**	**08**
VIII	**System of Geometric Dimensioning and Tolerancing (GD&T)**	**04**	**00**	**04**	**04**	**08**
IX	**Details & assembly**	**06**	**02**	**00**	**08**	**10**
	Total	**42**	**14**	**16**	**40**	**70**

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

Note: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly 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: Students should perform following activities. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Solve all problems for all sheets number 1 to 8 in sketch book (with complete data and dimensions).
b) Take two simple objects in your vicinity and sketch 3D isometric of them. Also draw 2D orthographic projections of them (all views). Try to clearly and accurately capture all the geometric features present in the selected objects.
c) Take a visit of manufacturing industry and prepare production drawing of simple part manufactured by that industry.
d) List out different weld joints carried out in fabrication industry.
e) Download soft copy of technical drawing of any engineering products. Read and interpret this drawing (e.g. connecting rod, piston, pulley etc.).
f) 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 batch student.
g) 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) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4*** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide students for using BIS "SP 46:2003", ASME Y14.3-2003 & ASME Y14.5-2009 standard.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. 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 duration of the micro project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Make a poster presentation on exploded view of mechanical components.
b) Take a simple assembly of 3 to 4 parts and prepare its assembly and detail drawing.
c) Model Making: Students should build 3D model of various object as per shape and dimension from thermocol, hardboard scrap, wooden scrap, plastic or metal scrap.
d) World of work connect: Students should collect Production drawings from nearby workshops/industries and try to
   - redraw types of lines used
   - redraw lettering styles used
   - list ASME code referred
   - list the symbols/annotations/dimensioning used

- list the type of scales used. Compare the size of component on drawing sheet with actual component.
- Redraw the 2D entities

13. SUGGESTED LEARNING RESOURCES

Sr.	Title of Book	Author	Publication with place, year & ISBN
1	Engineering Drawing	N.D. Bhatt	Charotar Publishing House;Anand, 2014. ISBN : 9789380358963
2	Engineering Drawing	M.B. Shah, B.C. Rana	Pearsons. 2009 ISBN: 9788131759714
3	SP 46-2003	-	Bureau of Indian Standards; Old Delhi, 2003 ISBN-10: 8170610192
4	Textbook of Engineering Drawing	P.J. Shah	S.Chand, New Delhi. 2013 ISBN : 9788121941822
5	Textbook of Engineering Drawing	R K Dhawan	S.Chand, New Delhi. 2013 ISBN : 9789352837373
6	Machine Drawing	N.D. Bhatt	Charotar Publishing House;Anand, 2014 ISBN-13: 9789385039232
7	Machine Drawing	P.J. Shah	S.Chand; New Delhi, 2013 ISBN-13: 9788121929660
8	Geometric Dimensioning & Tolerancing for Mechanical Design	Gene R. Cogorno	McGraw Hill; Noida,2011 ISBN-13: 9780071772129
9	Westermann Tables for the Metal Trade	Jutz Hermann	New Age International Pvt. Ltd.; Hyderabad, 2018 ISBN-13: 9788122417302
10	BIS IS 696 - 1972 BIS 919 (Part 1 and 2): 1993	-	-

14. SOFTWARE/LEARNING WEBSITES

Unit	Software/Learning Websites	
1.1	Drawing equipments, instruments and materials	https://youtu.be/MT1T31GtGpg
2.1	Types of lines, systems of dimensioning, scale	https://youtu.be/nUD4SBtu0GA
3.1	Conic sections : Ellipse	https://youtu.be/hG38kPDN2fU
	Ellipse by Four center method	https://youtu.be/YX_vqD83uhI
	Draw Parabola	https://youtu.be/dn3-9N_lzEo
	Draw Hyperbola	https://youtu.be/QEpS0QBwoas
	Directrics method to draw conic curves	https://youtu.be/aBk_DSToBbI
4.1	Development of surfaces Part 1	https://youtu.be/EVTrZ-ApC7g
4.2	Development of surfaces Part 2	https://youtu.be/a5C_VPEkUtI
5.1	Orthographic projections	https://youtu.be/55mR97uzjys
5.4	Sectional views	https://youtu.be/5bkG-LTb6-s

6	Isometric view from orthographic views	https://youtu.be/trJQIvatIpI
7.1	Mechanical drafting symbols	https://youtu.be/KdeeZeKO7ko
7.2	Drafting, geometric and welding symbol	https://youtu.be/H4koN4WSRSM
7.3	Piping symbols	https://youtu.be/euySmmCnzpA
1 to 9	https://nptel.ac.in/courses/112/103/112103019/ https://nptel.ac.in/courses/112/105/112105294/ https://www.youtube.com/c/MechanicalEnggSubjectsGTU/playlists https://youtube.com/playlist?list=PL5Rqb_WO7qVy2-6FluBrQcJh__rXvyOxe https://youtube.com/playlist?list=PL5Rqb_WO7qVxzROfyk2EusQDokGkLXVax	
Study following QR codes:		

15. PO-COMPETENCY-CO MAPPING

Semester I	Mechanical Drawing and Drafting (Course Code: 1316501)						
	POs						
Competency & Course Outcomes	**PO 1 Basic & Discipline specific knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ develop-ment of solutions**	**PO 4 Engineering Tools, Experimen-tation & Testing**	**PO 5 Engineering practices for society, sustainability & environment**	**PO 6 Project Manage-ment**	**PO 7 Life-long learning**
Competency							
Course Outcomes CO 1)Use scales, drawing standards and drafting instruments as per BIS codes.	3	-	2	3	-	-	2
CO 2)Construct engineering curves as per given dimensions.	3	-	3	2	2	-	2
CO 3)Draw orthographic and sectional orthographic views from isometric views of simple objects and vice versa.	3	2	3	2	2	2	2
CO 4)Apply Geometric Dimensioning and Tolerancing techniques to machine parts in a manner that complys with the ASME Y14.5-2009 standard.	2	3	2	3	2	2	3

CO 5) Prepare assembly and detail drawing of various mechanical components.	2	2	2	2	2	-	2

*Legend: '**3'** for high, '**2**' for medium, **'1'** for low and **'-'** for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Dr. H. R. Sapramer Head of Mech. Dept.	Dr. J. N. Mehta Polytechnic, Amreli	9426587197	merhamir@gmail.com
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