GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Mechanical Drafting
(Course Code: C4321902)

Diploma programme in which this course is offered	Semester in which offered
Mechanical, Marine, Mechatronics	Second

1. RATIONALE

The students of mechanical engineering programme are mainly involved in drafting, manufacturing, inspection and planning activities (such as preparing process plans, preparing bill of materials, etc.) at industries. For all such activities, reference document is the drawing of components/assemblies to be manufactured. In this context, it is of utmost priority to prepare, read and interpret these drawings correctly for production of components and assemblies accurately and precisely. The industrial practices of drafting are also important for the students to make them aware of drafting practices, symbols, codes, norms and standards generally used in industries. Development of sketching ability also strengthens effective engineering communication & presentation.

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 drawings using codes, norms and standards.**
- **Interpret basic engineering drawings for various planning, manufacturing activitiesand 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 theachievement of the following COs:

a) Prepare sectional orthographic views of complex mechanical parts as per**ASME Y14.3-2003** standard.
b) Draw lines/curves of intersection of pipe lines and ducts like solid.
c) Develop the lateral surface of given combination of solid.
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	
2	0	4	4	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	**Multiviews with Sectional Views:** 1a. Given the pictorial view, draw multi views. -Two problems. 1b. Faculty has to assign objects and multi views have to be drawn. (From mutliviews i.e., FV, TV, RV, BV, RHSV&LHSV, one view of each problem must be *sectional view*)	I	10
2	**Missing Views:** Given adequate number of minimum views, draw additional view/s asasked. -Three problems.	I	04
3	**Penetration and Intersection:** Draw the intersection curves-4 problems. (1. Prism into Prism, 2. Cylinder into Cylinder, 3. Cylinder into Prism& 4. Cone into Cylinder.)	II	08
4	**Surface Development:** Draw development of surface - 4 problems (*3 problems* fromPrism, Pyramid, Cylinder and Cone – independent and sectioned&*1 problem* from combination of any two as suggested in Topics & Sub-Topics 3.5)	III	06
5	**Details:** Draw the details of all parts for the assembly assigned and sketched asstudent activity.	VI	12
6	**Assembly:** Draw the assembly of all parts assigned by faculty. This includesminimum one sectional view and also prepare BOM.	VI	10
7	**Production Drawing:** Draw the production drawing of simple machine components	V	06

Sheet No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	assigned by faculty. This includes Geometric & Dimensional Tolerances (GD&T), Surface Roughness Symbols, Open Dimensional Tolerances, Notes, etc.,		
8	**Mechanical DraftingSymbols& Fasteners:** *Draw following symbols & its interpretation:* Drafting Symbols (Machining, threading,dowels, pins, ribs, bearings, heat treatmentconditions, surface conditions, assemblynotes), Welding Symbols (as per BIS-813 / ASME, primary symbols & supplementarysymbols), Piping Symbols (Pipe line symbol as per passing fluid, air, gas, water etc. and Piping fitting symbols.) *Draw sketches of following fasteners & its interpretation:* Sketches of threads (square, acme,knuckle, Internal – external threads,left hand – right hand threads, Single &multi start threads). Sketches of studs (cap screws, machinescrews, set screws). Sketches of bolts & nut (hexagonal,square). Sketches of rivets (snap, pan,countersunk, conical). Sketches of keys.	IV& VII	-
	Minimum8PracticalExercises		**56**

Note

i. *The sketchbook should contain data related to all problems, solutions of all problems and student activities performed. Students' activities are compulsory to be performed.*
ii. *Draw freehand sketch of Sheet No.8 data in sketchbook only.*
iii. *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.*
iv. *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.*
v. *Faculty 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.*
vi. *First angle orthographic projection and codes* (SP 46:2003, ASME Y14.3-2003 & ASME Y14.5-2009) *should be followed wherever applicable.*
vii. *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.*
viii. *A softcopy containing applicable standards from* IS codes, ASME Y14.3-2003 & ASME Y14.5-2009 *should be accessible to students.*

ix. 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 specificationsfor the PrOsis a guide to procure them by the administrators to user in uniformity of practical in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1.	Drawing instruments for class room teaching (Large Size).	1 to 7
2.	Models of various objects	1, 3, 5, 6, 7
3.	Drawing Board (B2) & Mini Drafter.	1 to 7
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.	1 to 7
5.	Set of various drawings being used by industries/developed by experienced teachers.	4, 5, 6, 7
6.	Interactive board with LCD overhead projector	1 to 7

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample***Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs andPrOs.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 **Multiviews with sectional orthographic representation**	1a. Draw multi views of an object. 1b. Interpretation of multi views drawings. 1c. Draw sectional orthographic views of an object. 1d. Interpretation of sectional orthographic views.	1.1 First & third angle projection methods & and positions of six views.Importance of it in engineering drawing field. 1.2 Multi view drawings (all six views) from given isometric drawing / pictorial view. 1.3 Need of sections, section lines &cutting plane, rules forsectioning and section lines. 1.4 Types and application of sections- full, half, revolved, removed, partial, off-set, aligned, etc. 1.5 Sectional view drawings from given isometrics drawing / physical object and cutting plane conditions. 1.6 Missing view drawings from given adequate orthographic views. (**Faculty**should**demonstrate**the physical model/dirty model/3D CAD model for better conceptualization and in depth understanding of topic.)
Unit– II **Intersection and Penetration of Solids and Surfaces**	2a. Draw intersection/ penetration views of an object.	2.1 Types and dimensional specifications ofsolids (prism, pyramid, cylinder, cone). 2.2 Importance and field use/industrial applications with examples of intersection/penetration. 2.3 Intersection curve for Intersection/ penetration of: - Prism into prism. - Cylinder into cylinder. - Cylinder into prism. - Cone into cylinder. 2.4 Discussion / demonstration of moderate

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
		industry objects related to topic.
	3a. Develop the surfacerequirement of given application.	3.1 Importance and field use / industrial applications of development ofsurfaces. Introduction to cutting planes / section planes, positions of the cutting plane (HCP, VCP, PCP, AVP &AIP) w.r.t solids. 3.2 Drawing of development of surfaces of various solid - surface development of combination of different solids and of sectioned solids of: - Prism - Cylinder & Cone - Pyramid 3.3 Surface development of combination of any two solid (example: pipe joints, litre can, funnel, etc.)
Unit-IV **Mechanical DraftingSymbols**	4a. Use & interpretmechanical drafting symbols.	4.1 Drafting Symbols (Machining, threading, dowels, pins, ribs, bearings, heat treatment conditions, surface conditions, assembly notes.) 4.2 Welding Symbols (as per BIS-813 / ASME, primary symbols & supplementary symbols.) 4.3 Piping Symbols (Pipe line symbol as per passing fluid,air, gas, water etc. and Piping fitting symbols.) 4.4 Demonstration of above symbol in production drawing.
Unit-V **System of Geometric Dimensioning and Tolerancing (GD&T)**	5a. Use & interpret Geometric & Dimensioning Tolerances (GD&T) in production drawing.	5.1 Difference between dimensional tolerance & geometric tolerance. Limits & Fits–Introduction, need & applications. 5.2 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. 5.3 Selection of appropriate shaft / hole for a given condition, calculation of tolerances & deviations for a fit according to application of mating parts. 5.4 Geometric Tolerances – Introduction, symbols, representation, meaning of each element of tolerance frame and

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
		application in industrial drawing. (**Faculty** should **demonstrate**&**discuss** moderate production drawing for better understanding of topic)
Unit-VI **Details & Assembly**	6a. Prepare andinterpret detail andassembly drawing. 6b. Workout bill of material (BOM) from a given drawing.	6.1 Importance and difference of these drawings. 6.2 Detail drawing from given assembly. 6.3 Assembly drawings from given details and prepare BOM.
Unit-VII **Fasteners**	7a. Use appropriatefastener s for givensituations. 7b. Draw sketches fordifferent types offasteners.	7.1 Detachable & permanent fasteners. 7.2 Sketches of threads (square, acme,knuckle, Internal – external threads,left hand – right hand threads, Single & multi start threads). 7.3 Sketches of studs (cap screws, machinescrews, set screws). 7.4 Sketches of bolts & nut (hexagonal,square). 7.5 Sketches of rivets (snap, pan,countersunk, conical). 7.6 Sketches of keys.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Multi views with Sectional Orthographic Representation	06	00	00	14	14
II	Intersection &Penetration of Solids &Surfaces	06	00	04	06	10
III	Development of Surfaces	05	00	02	06	08
IV	Mechanical Symbols	04	06	04	00	10
V	System of Geometric Dimensioning and Tolerancing (GD&T)	04	02	04	04	10
VI	Details &Assembly	03	02	00	10	12
VII	Fasteners	-	04	00	02	06
	Total	**28**	**14**	**14**	**42**	**70**

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

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 in group and prepare reports of about 5 pages for each activity. 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 7 in sketch book (with complete data and dimensions).
b) Prepare list of products nearby you which is made by development of surface.
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 assessedusing 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 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) Creating Digital Portfolio:Students should Observe and collect photographs and images of industrial/domestic components/items which utilize intersection of solid.
b) Make a poster presentation on exploded view of assembly of mechanical components.
c) Take a simple assembly of 3 to 4 parts and prepare its assembly and detail drawing.
d) 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.
e) 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/BIS 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. No.	Title of Book	Author	Publication with place, year and ISBN
1	Engineering Drawing	N.D. Bhatt	Charotar Publishing House;Anand, 2014 ISBN-13: 9789380358963
2	Machine Drawing	N.D. Bhatt	Charotar Publishing House;Anand, 2014 ISBN-13: 9789385039232
3	Machine Drawing	P.J. Shah	S.Chand; New Delhi, 2013 ISBN-13: 9788121929660
4	Machine Drawing	K. L. Narayana, P. Kannaiah, K. Venkata Reddy	New Age International Pvt Ltd; New Delhi, 2016 ISBN-13: 9788122440546
5	Engineering Graphics	M.B.Shah, B.C.Rana	PearsonEducation; Ahmedabad,2009 ISBN-13: 9788131710562
6	Engineering Drawing Vol 1 & 2	K. R.	Subhash Publications;

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
	Combined	Gopalakrishna	Bengaluru, 2017 ISBN-13: 9789383214235
7	The Fundamentals of Engineering Drawing: With An Introduction To Interactive Computer Graphics For Design And Production	Warren J. Luzadder, Jon M. Duff	Pearson India; Bengaluru, 2015 ISBN-13: 9789332549982
8	Technical Drawing	W. Abbott, Revised by T. H. Hewitt	English Language Book Society and Blackie & Son Ltd.; London, 1978 ISBN-10: 021690210X
9	Geometric Dimensioning and Tolerancing for Mechanical Design	Gene R. Cogorno	McGraw Hill; Noida,2011 ISBN-13: 9780071772129
10	Westermann Tables for the Metal Trade	Jutz Hermann	New Age International Pvt. Ltd.; Hyderabad, 2018 ISBN-13: 9788122417302
11	SP 46-2003	-	Bureau of Indian Standards; Old Delhi, 2003 ISBN-10: 8170610192
12	BIS 696 - 1972	-	-
13	BIS 919 (Part 1): 1993& BIS 919 (Part 2): 1993	-	-

14. SOFTWARE/LEARNING WEBSITES

Mechanical Drafting Subject

- https://youtube.com/playlist?list=PL5Rqb_WO7qVxzROfyk2EusQDokGkLXVax
- https://nptel.ac.in/courses/112/103/112103019/
- https://nptel.ac.in/courses/112/105/112105294/

Multiviews with sectional orthographic representation

- https://youtu.be/55mR97uzjys
- https://youtu.be/5bkG-LTb6-s
- https://youtu.be/uiZ8Xl0QTkU
- https://youtu.be/o2s7A658rag

Missing views

- https://youtu.be/NQU_ml5xpo8

Intersection and Penetration of Solids and Surfaces

- https://youtu.be/5bkG-LTb6-s
- https://youtu.be/vhYe-E99bog
- https://youtu.be/fudq7JQiwjs
- https://youtu.be/l0PVFFaQAf4
- https://youtu.be/V5p8DGL63Ho
- https://youtu.be/0h56yj3AHNc
- https://youtu.be/A1CKh4zewd4
- https://youtu.be/Ume3AD38-Vk

Development of Surfaces

- https://youtu.be/EVTrZ-ApC7g

- https://youtu.be/a5C_VPEkUtI
- https://www.youtube.com/playlist?list=PLUqOKW86QrMblA4NuoaCgGVKXrjZtOb5i
- https://www.youtube.com/playlist?list=PLIhUrsYr8yHwdB96ft6c0Uwc4SDCLuG1v
- https://www.youtube.com/watch?v=mEIYKa1x2Y4&list=PLSJ0s_ue4lgjMr7sFOuyQQVTihpR_fBrU
- https://www.youtube.com/watch?v=P5oPrynRsTI

Mechanical Symbols

- https://youtu.be/KdeeZeKO7ko
- https://youtu.be/euySmmCnzpA
- https://www.youtube.com/watch?v=A-J-tQEuACA
- https://www.youtube.com/watch?v=gAyceJb5OWc
- https://www.youtube.com/watch?v=4p3FzrMxRtA
- https://www.youtube.com/watch?v=PIjLvwe_uMY

System of Geometric & Dimensioning Tolerances (GD&T)

- https://youtu.be/IQHcIi8X360
- https://www.youtube.com/watch?v=joBy4BoJszo
- https://www.youtube.com/watch?v=RYQUXGSEsV0
- https://www.youtube.com/watch?v=-3tN7KvDUjQ
- https://www.youtube.com/watch?v=NZ_zAqvNcFo
- https://engineeringandindustry.medium.com/reading-a-production-drawing-1d0fc94f45eb

Details & Assembly

- https://www.youtube.com/playlist?list=PLSJ0s_ue4lgiBn3PWHLN5TtiuFHLByEsN

Fasteners

- https://www.youtube.com/watch?v=y6DnJ0HEmCI
- https://www.youtube.com/watch?v=hlGcb72II5Q

15. PO-COMPETENCY-CO MAPPING

Semester I	Instrumentation Workshop (Course Code: C4311702)						
	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	✓ Draw various mechanical component drawings using codes, norms and standards. ✓ Interpret basic engineering drawings for various planning, inspection and manufacturing activities.						
Course Outcomes CO 1) Prepare sectional orthographic views of complex mechanical parts as per ASME Y14.3-2003 standard.	2	2	-	2	-	-	-

CO 2) Draw lines/curves of intersection of pipe lines and ducts like solid.	2	2	2	-	-	-	2
CO 3) Develop the lateral surface of given combination of solid.	2	2	2	-	-	-	2
CO 4) Apply Geometric Dimensioning and Tolerancing techniques to machine parts in a manner that complies 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

GTU Resource Persons

Sr.	Name and Designation	Institute	Contact No.	Email
1.	Dr. Sunil S. Sonigra, Lecturer in Mech. Engg.	Government Polytechnic, Rajkot	9427322129	sssonigra@gmail.com
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3.	Prof.Dipak A. Solanki, Lecturer in Mech. Engg.	Government Polytechnic, Porbandar	9016221933	dipak.solanki.gp@gmail.com

BOS Resource Persons

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3	Dr.Atul.S. Shah BOS Member Principal	B.V.Patel Institute of Technology Bardoli	7567421337	Asshah97@yahoo.in