GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023) Semester-VI

Course Title: Design of Machine Elements

(Course Code: 4362007)

Diploma program in which this course is offered	Semester in which offered
Mechanical Engineering, Mechatronics Engineering	6th Semester

1. RATIONALE

For production of machine parts and components it is required that specific shape and size of machine parts are determined and their drawings are prepared. We also have to select specific material for that product. This process is called as design. In designing a machine component it is necessary to have a good knowledge of many subjects such as Mathematics, Engineering Mechanics, Strength of Materials, Theory of Machines, Workshop Processes and Engineering Drawing. Students have learnt these subjects in previous semesters. This course curriculum provides the students' knowledge of design process, as well as familiarity with design of components subjected to various stresses and moments like direct stress, bending stress, twisting moment and combined stresses. In this course students will learn design of machine components/elements like cotter joint, knuckle joint, power screw, levers, helical and leaf springs, couplings, pressure vessels, bearings, etc.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competencies:

- **Design a simple machine element with appropriate material for given user defined boundary and loading conditions.**

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:

CO-1	Identify various failures and its resisting areas of machine element.
CO-2	Make use of preferred number for standardization of element dimensions in given range.
CO-3	Design machine element subjected to Direct, Bending, Twisting and Combined load.
CO-4	Determine the safe dimensions of thin and thick cylinder pressure vessel.

CO-5	Calculate important characteristics of sliding and antifriction bearing.

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	2	4	30*	70	25	25	150

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

(*): 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.

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the sub-components of the Course Outcomes (COs). Some **POs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to the 'Psychomotor Domain.'

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
01	**Preparatory Activity :** 1. Interpret and write various course related SI units and their conversions. 2. Write normal values of ultimate tensile strength, yield strength, density, modulus of elasticity and Poisson's ratio of commonly used materials. 3. List normal values of factor of safety for different situations. 4. Recall area, volume, section modulus, moment of inertia, radius of gyration, etc. for commonly used various section and shapes. 5. Draw orthographic projections symbols. 6. Draw symbols of threads, surface roughness, geometrical tolerances symbols, section lines, etc. 7. Recall by sketching the general systems for limits, fits and tolerances.	ALL	02

02	**Standardization using preferred number*** Teacher will provide required data for standardization of 1. Speed of shaft 2. Size of structural product like round bar, plate, sheet etc. 3. Weight of packages 4. Size of industrial design like electric motor, tractor, machine tool, crane 5. Size of machine parts like pulley, coupling 6. Size of cutting tool like drill, broach	I	02
	(minimum one example from each case)		
03	**Design of simple components subjected to direct load** Teacher will also assign material, load, factor of safety and other data for design of following components: 1. Simple component 2. Riveted joint (Two to three example from each case decided by faculty)	II	02
04	**Design of simple components subjected to bending load*** Teacher will also assign material, load, factor of safety and other data for design of following components: 1. Lever 2. Leaf spring (Two to three example from each case decided by faculty)	III	02
05	**Design of simple components subjected to twisting moment** Teacher will also assign material, load, factor of safety and other data for design of following components: 1. Shaft 2. Key 3. Helical spring (Two to three example from each case decided by faculty)	IV	02
06	**Design of simple components subjected to eccentric load*** Teacher will also assign material, load, factor of safety and other data for design of following components: 1. C-Clamp 2. Bracket 3. Column of drilling machine (Two to three example from each case decided by faculty)	V	02
07	**Design of Cotter joint*** Teacher will also assign material, load, factor of safety and other data for design of Cotter joint.	II	02
08	**Design of Knuckle joint*** Teacher will also assign material, load, factor of safety and other data for design of Knuckle joint.	II	02

09	**Design of Flange coupling*** Teacher will also assign material, load, factor of safety and other data for design of Flange coupling.	IV	02
10	**Production drawings of design assemblies:** 1. Cotter joint 2. Knuckle joint 3. Flange coupling Give desired geometrical and dimensional tolerance. Show dimensions calculated above at exercises number 7 to 9. (Prepare production drawing either manually or using software. Use A4 size paper only.)	II & IV	04
11	**Design of pressure vessel:*** 1. Thin cylinder 2. Spherical cylinder 3. Thick cylinder (Two to three example from each case decided by faculty)	VI	02
12	**Calculation of features/characteristics of Bearings*** Teacher will provide required data for calculation of different characteristic of bearing like bearing life, dynamic capacity, bearing characteristic number, coefficient of friction, bearing pressure, heat generation etc. for 1. Journal Bearing 2. Anti-friction Bearing (Three to four example from each case decided by faculty)	VII	04
Total (Hours)		-	**28**

Note:

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

Criteria	Rating Scale for Preparatory activity

	%	NEED IMPROVEMENT (1)	FAIR (2)	GOOD (3)	EXCELLENT (4)

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. No.	Sample Performance Indicators for the PrOs	Weightage in %
For Preparatory activity (PrOs Number: 1)		
1	Knowledge	30
2	Quality of Report	30
3	Participation	20
4	Punctuality	20
Total		**100**
Calculation type PrOs (PrOs Number: 2 to 9, 11 & 12)		
1	Recognition	20
2	Solution	30
3	Representation	20
4	Application	20
5	Punctuality	10
Total		**100**
Rating Scale for Production Drawing type PrOs (PrOs Number: 10)		
1	Drawing Layout, Planning & Scale	20
2	Dimensioning, Tolerances and Notations	30
3	Use of appropriate Line	20
4	Accuracy and Neatness/Drawing setting	20
5	Timely completion	10
Total		**100**

Sample rubrics Performance Indicators for the PrOs

Knowledge	30%	Student give the correct answers less than 50%.	Student give the correct answers between 5069%.	Student give the correct answers between 70-89%.	Students give the correct answers 90% or more.

Quality of Report	30%	Several elements are missing (content in paragraph, labels, figures, tables).	A few required elements (labeling/ notations) are missing.	Only formatting is improper (Location of figures/tables, use of pencil and scale).	Neat Handwriting, figure, and table. Complete labeling of figure and table.
Participation	20%	Participation is minimum.	Focused limited attention in the exercise.	Moderately focused attention on exercise.	Excellent focused attention in the exercise.
Punctuality	20%	Submission late by more than two laboratories.	Submission late by two laboratories.	Submission late by one laboratory.	Timely Submission.

Criteria	**Rating Scale for Calculation type PrOs**				
	%	**NEED IMPROVEMENT (1)**	**FAIR (2)**	**GOOD (3)**	**EXCELLENT (4)**
Recognition	20%	Little to no recognition of relevant information necessary to solve problem(s)	Somewhat recognizes relevant information to solve problem(s)	Mostly recognizes relevant information to solve problem(s)	Clearly recognizes of relevant information necessary to solve problem(s)
Solution	30%	Calculation is carried out step by step with more than 30% mathematical error and given data is not written properly	Calculation is carried out step by step with 30% mathematical error and given data is not written properly	Calculation is carried out step by step with 30% mathematical error or given data is not written properly	Calculation is carried out step by step with no mathematical error and given data is written properly
Representation	20%	Lacks ability to represent information in a variety of modes/forms	Somewhat able to represent information in a variety of modes/forms	Mostly able to represent information in a variety of modes/forms	Definitely able to represent information in a variety of modes/forms

Application	20%	Applies few to no concepts/principl es necessary to solve problem(s)	Applies some concepts/princi ples necessary to solve problem(s)	Applies most concepts/princip les necessary to solve problem(s)	Applies all concepts/princip les necessary to solve problem(s)
Punctuality	10%	Assignment work is submitted more than 4 days lately	Assignment work is submitted late within 2 to 4 days	Assignment work is submitted late within 2 days	Assignment work is submitted within time limit

Criteria	**Rating Scale for Manual Production Drawing type PrOs**				
	%	**NEED IMPROVEMENT (1)**	**FAIR (2)**	**GOOD (3)**	**EXCELLENT (4)**
Drawing Layout, Planning & Scale	20%	The drawing views provided are not sufficient, correct or appropriate and not drawn to the appropriate scale	50% of drawing views provided are sufficient, correct or appropriate and drawn to the appropriate scale	80% of drawing views provided are sufficient, correct appropriate and drawing is to the appropriate Scale.	All drawing with proper planning, layout and to the appropriate scale.
Dimensioning, Tolerances and Notations	30%	Drawing without proper Dimensioning, tolerances and notations.	50% of drawing dimensions, tolerances and notation are given Correctly.	80% of drawing dimensions, tolerances and notation are given Correctly.	All dimension, tolerances and notations are given in drawing.
Use of appropriate Line	20%	No rules were followed. Unable to set the line class. Did not use correct line type or weight	Inconsistent lines, dark and light line combination is not proper.	Two or three lines are not shown in proper type or shade.	Crisp, clear, consistent lines, Proper line type, proper light and dark combination of line.

Accuracy and Neatness for manual drawing / Drawing setting for software drawing	20%	There are many smudges and erasures or stray marks on the drawing sheet, which detract from the drawing and overall poor quality of drawing.	More than two smudge and erasures or stray marks on the drawing sheet, which detract from the drawing.	One or two smudge and erasures or stray marks on the drawing sheet, but they do not greatly detract from the drawing.	No smudge and almost no erasures or stray marks on the drawing.
		Not set drawing limit and dimension unit is not proper.	Minor error in drawing limits setting but do not select proper dimension unit.	Either Drawing limits do not set very well or do not select proper dimension unit.	Drawing limits set very well. Select proper dimension unit.
Timely completion	10%	Drawing work is completed late by more than 2 laboratories.	Drawing work is completed late by 2 laboratories.	Drawing work is completed late by 1 laboratory.	Drawing work is completed within time limit.

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

Sr. No.	Equipment Name	PrOs. No.
1.	Assorted levers, Leaf Springs, shafts, keys, Helical Spring, C-clamps, frames, other machine components.	3,4,5,6
2.	Wooden models (with cut sections) of knuckle joint, cotter joint, flange coupling	7,8,9
3.	Assorted bearings	12
4.	Educational charts/models of different machine elements subjected to various stresses.	ALL

7. AFFECTIVE DOMAIN OUTCOMES

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

a. Work as a leader/ team member.

b. Follow safety practices.

c. Follow ethical practices

d. Maintain tools and equipment

e. Practice environment-friendly methods and processes. (Environment related)

The ADOs are best developed through 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

Based on the higher-level UOs of Revised Bloom's taxonomy formulated for developing COs and competency, the primary underpinning theory is given below. If required, more such UOs could be included by the course teacher to focus on attaining COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit – I Introduction.	1.a List various factors to be considered for design process. 1.b Identify and select materials that can be used for design of machine elements. 1.c Explain loads, stresses, stress concentration factor and factor of safety.	1.1 General consideration and factors influencing the design of machine elements and design process. 1.2 Various materials used in manufacturing of machine elements and their properties. 1.3 Types of loads, types of stresses, concentration and factor of safety. 1.4 Standardization and preferred numbers, numeric examples on preferred numbers.
	1.d List Types of loads, types of stresses 1.e Select standard items and preferred numbers for designing simple machine elements.	
Unit– II Design of machine elements subjected to direct stresses.	2.a Describe the design process of simple elements like linkages, etc. 2.b Calculate resisting area of simple machine element subjected to direct independent stress. 2.c Explain the design of cotter joint and knuckle joint. 2.d Explain the design process of riveted joint and threaded fasteners.	2.1 Illustration of simple machine elements subjected to direct stresses-independently and identification of resisting areas (simple numeric examples). 2.2 Design of simple machine elements subjected to uni-axial direct stressesindependently. 2.3 Design procedure (with numeric examples), steps, identification of resisting areas and design of: i. Knuckle joint ii. Cotter joint. iii. Riveted joints.

Unit-III Design of machine elements subjected to bending stresses.	3.a State the fundamental bending equation. 3.b State modulus of various sections subjected to pure bending like levers, beams and axles. 3.c List types of levers. 3.d Design simple lever based on given input. 3.e Design leaf spring.	3.1 Principle of bending and its fundamental equation. 3.2 Modulus of various sections, example of pure bending like levers, beams, axle, etc. 3.3 Types of levers. 3.4 Design procedure (with numeric example) of levers including cross section of arms, bosses and pins. 3.5 Design procedure (with numeric example) of leaf spring.
Unit-IV Design of machine elements subjected to direct and twisting moments.	4.a State fundamental equation of twisting moment. 4.b List types of shafts with important features of each. 4.c List types of keys, couplings, spring & applications of each. 4.d Explain the design procedure of shafts, keys and couplings. 4.e Define helical spring terminology and its applications. 4.f Calculate numerical on	4.1 Fundamental equation of twisting moment with design procedure. 4.2 Types of shafts with important features of each. 4.3 Design of shafts (with numeric examples). 4.4 Types of keys, applications of each and design procedure (with numeric examples). 4.5 Types of couplings and applications. 4.6 Design of muff and flange couplings (with numeric examples). 4.7 Types of spring, terminology related to helical spring and applications of helical spring.
	the design procedure of machine elements subjected to twisting moment.	
Unit-V Design of machine elements subjected to direct and bending stresses.	5.a Define eccentric loading. 5.b Draw frame-clamp, Bracket, Column of drilling machine, etc. 5.c Design machine components subjected to eccentric loading.	5.1 Eccentric loading- i. Concept, ii. Illustrations like frame, C-clamp, Bracket, Column of drilling machine etc. iii. Design of machine element like CClamp, bracket, Column of drilling machine. (with numeric examples).

Unit-VI Design of pressure vessels.	6.a Define pressure vessels 6.b State types of pressure vessels with range of pressure. 6.c Design simple thick and thin cylinder pressure vessels. 6.d Design simple thin spherical shell.	6.1 Types and applications of pressure vessels used in industries. State Range of pressure also. 6.2 Design of thick and thin cylinders (with numeric examples). 6.3 Design of thin spherical shell (with numeric examples).
Unit-VII Selection procedure for bearings.	7.a Classify bearings. 7.b Explain designation of bearings. 7.c Select appropriate antifriction bearings from manufacturer's catalogue. 7.d Calculate the load on the bearings.	7.1 Classification of bearings. 7.2 Bearing designation as per IS. 7.3 Antifriction bearings: types, advantages, applications. 7.4 Selection procedure of anti-friction bearings. 7.5 Calculation for anti-friction bearings: basic dynamic load, load rating, equivalent load, bearing life.

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	Introduction.	08	3	7	4	14
II	Design of machine elements subjected to direct stresses	09	3	4	7	14
III	Design of machine elements subjected to bending stresses	05	0	0	7	7
IV	Design of machine elements subjected to direct and twisting moments.	08	4	3	7	14
V	Design of machine elements subjected to direct and bending stresses.	04	0	3	4	7
VI	Design of pressure vessels.	04	0	3	4	7

VII	Selection procedure for bearings.	04	4	3	0	7
Total		**42**	**14**	**23**	**33**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

Sr. No.	Activity.
1.	Download and present various presentations related to stresses in machine elements.
2.	Download and present various presentations related to failure of machine elements.
3.	Download and present various presentations related to design of machine elements.
4.	Prepare/Download a dynamic animation to illustrate the following: i. Knuckle joint. ii. Cotter joint. iii. Flange Coupling

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies that the course teacher can use to accelerate the attainment of the various outcomes in this course.

Unit	Unit Title	Strategies
I	Introduction.	Power point presentations, live examples, demonstration of BIS on preferred numbers and standardizations,
II	Design of machine elements subjected to direct stresses.	Movies/ animations/ educational charts, videos & model of different machine elements subjected to various stresses, live demonstration of failed components,
III	Design of machine elements subjected to bending stresses.	Movies/ animations/ educational charts, videos & model of different machine elements subjected to bending, live demonstration of bending and induced stresses.
IV	Design of machine elements subjected to direct and twisting moments.	Movies/ animations/ educational charts, videos & model of different machine elements subjected to twisting, live demonstration of twisting.
V	Design of machine elements subjected to direct and bending stresses.	Movies/ animations/ educational charts, videos & model of different machine elements subjected to direct and bending stresses.
VI	Design of pressure vessels.	Movies/ animations/ educational charts, videos, demonstration of live pressure vessels.
VII	Selection procedure for bearings.	Movies/ animations/ educational charts, videos, live demonstration of bearings, demonstration of BIS catalogues

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her at the beginning of the semester. 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 with in integration of PrOs, UOs, and ADOs. Each student must maintain a dated work diary (Logbook) consisting of individual contributions to the project work and give a seminar presentation 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 a micro-project by the end of the semester to develop the industry-oriented COs.

A representative list of micro-projects is given here. This has to match the competency and the COs. The concerned faculty can add similar micro-projects based on student activities (chart/presentation/report/model):

1. Prepare model of simple mechanical element to show different types of stress induced in it.
2. Prepare a tabulated summary which shows the standard value of factor of safety based on types of load and types of material. Take reference of design data book.
3. Prepare a chart to represent different shapes like Round bar, Square bar, Steel flat, Different section like L, T, I and C and sizes of some structural members as per IS Code.
4. Prepare a chart to shows stress concentration acting on simple mechanical element.
5. Prepare a chart to represents all possible failure of cotter joints.
6. Prepare a chart to represents all possible failure of Knuckle joints.
7. Prepare a chart to represents all possible failure of flange coupling.
8. Collect different types of rivet.
9. Prepare model of different types of riveted joints. (like single riveted, double or triple riveted, lap joint or butt joint, single cover or double cover) 10. Prepare a demonstration model of the failure of Riveted Joint.
11. Prepare a chart to show the elements of screw thread.
12. Collect the mechanical elements or bolts to show different types of thread.
13. Prepare a tabulated summary to show moment of inertia and modulus of section for common sections.
14. Collect a semi elliptical leaf spring from scrap and prepare model to represents elements of leaf spring.
15. Collect the different types of keys used in industry.
16. Prepare model to represent failure of key.
17. Prepare chart/model to represent failure of thin cylinder.
18. Prepare chart to represent stress distribution in thick cylinder.
19. Prepare chart to represent construction of anti-friction bearing.
20. Prepare chart to represent different types of sliding contact bearing.
21. Prepare chart to represent different types of rolling contact bearing.

22. Take any real life problem (component) from day today life and design the same assuming the load and stresses for material.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication
1.	Machine Design	R.K.Jain	Khanna Publishers
2.	Machine Design	TVS Murthy and N.Shanmugam	Anuradha publications
3.	Machine Design	Pandya and Shah	Charotar Publishing House Pvt. Limited
4.	Machine Design	R.C.Patel and A.D.Pandya	Acharya Book Depot, 1959.
5.	Design of Machine Elements	Shigley	Tata McGraw-Hill Education
6.	Design Data Book	P.S.G. College of Technology, Coimbatore	P.S.G. Publication
7.	Design Data Book	K. Mahadevan & Balveera Reddy	S. Chand
8.	A Text book of Machine Design	R.S.Khurmi and J.K.Gupta	S. Chand
9.	Design of machine elements	V.B.Bhandari	McGraw-Hill

14. SOFTWARE/LLEARNING WEBSITES

1. Chapter: 1 Introduction.
   I. https://youtu.be/m9l1tVXyFp8
   II. https://youtu.be/jolY82CpmGo
   III. https://youtu.be/yH04FSBiCdk
2. Chapter: 2 Design of Machine elements subjected to direct stresses.
   I. https://youtu.be/OT6VcqvOoGY
   II. https://youtu.be/J9Aj17MAyLY
   III. https://youtu.be/C5ZPaCvoigw
3. Chapter: 3 Design of Machine elements subjected to Bending stresses.
   I. https://youtu.be/XSK4iupjbwY
   II. https://youtu.be/r04WynzyK-U
   III. https://youtu.be/E0hrPYAr8pA

4. Chapter: 4 Design of Machine elements subjected to direct and twisting moments.
   I. https://youtu.be/G0bShPqHn5c
   II. https://youtu.be/uGxfchLe-_I
   III. https://youtu.be/QfhIea6KzZA
   IV. https://youtu.be/46quOD7V-cQ
5. Chapter: 5 Design of Machine elements subjected to direct and bending stresses.
   I. https://youtu.be/E0hrPYAr8pA
   II. https://youtu.be/ py5xbKHGA
   III. https://youtu.be/1oMjw1YIGwg
6. Chapter: 6 Design of Pressure vessels.
   I. https://youtu.be/hTL8JMmfSC0
   II. https://youtu.be/erW4HZ5I928
7. Chapter: 7 Selection Procedure for bearings.
   I. https://youtu.be/q4E9yaulqyc

15. PO-COMPETENCY-CO MAPPING

Semester V	**Design of Machine Element (4351902)**						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline-specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long Learning
Competency	Design a simple machine element with appropriate material for given user defined boundary and loading conditions.						
CO-1: Identify various failures and its resisting areas of machine element.	2	2	-	-	-	-	-
CO-2: Make use of preferred number for standardization of element dimensions in given range.	2	2	-	-	2	-	2

CO-3: Design machine element subjected to Direct, Bending, Twisting and Combined load.	2	3	3	2	2	-	3
CO-4: Determine the safe dimensions of thin and thick cylinder pressure vessel.	2	2	2	-	-	-	-
CO-5: Calculate important characteristics of sliding and antifriction bearing	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. No.	Name and Designation	Institute	Contact No.	Email
1.	Prof. (Dr) J.B.Patel	SIR Bhavsinhji Polytechnic Institute, Bhavnagar	9998816294	jaybpti241120@gmail.com
2.	Prof. D. A. Solanki	Government Polytechnic, Porbandar	9016221933	dipak.solanki.gp@gmail.com
3	Mr. Mayank. M. Boda	Government Polytechnic, Jamnagar	9998142886	mayankboda.edu@gmail.com

17. BOS Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Dr. S. H. Sundarani, BOS Chairman & HOD Mechanical	Government Polytechnic, Ahmadabad	9227200147	gpasiraj@gmail.com
2.	Dr. Rakesh D. Patel, BOS Member & HOD Mechanical	B. & B. Institute of Technology, V. V. Nagar	9825523982	rakeshgtu@gmail.com

3	Dr. Atul S. Shah, BOS Member & Principal	B. V. Patel Institute of Technology, Bardoli	7567421337	asshah97@yahoo.in