GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Tool Engineering
(Course Code: 4351905)

Diploma program in which this course is offered	Semester in which offered
Mechanical Engineering	5th Semester

1. RATIONALE

Tools are as basic component for any machining process. The quality and efficiency of any machining operation basically depends upon quality of tools which in turn depends upon the proper shape, size and material of the tools. Productivity and quality of machining operations may further be enhanced by proper and quick mounting of tools and jobs on machines. Jigs and fixture play an import roll in this process. Therefore, this course attempts to develop abilities in students to select a tool of proper size and shape for required machining operation. The design of press tools, jigs, fixtures and limit gauges is also dealt with in this course. This course is therefore a core course for mechanical engineers.

2. COMPETENCY

The course content should be taught and implemented to develop different skills so that students can acquire the following competency.

- **Develop the ability to select and/or design cutting tools, tool holders, dies, jigs and fixture for given simple component.**

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	Use relevant cutting tools for given manufacturing operations.
CO-2	Identify and select locating and clamping devices for given component.
CO-3	Design jig and fixture based on components' geometry and machining operations.
CO-4	Identify appropriate press working operations for mass production of sheet metal parts.
CO-5	Select and design dies and limit gauges for a given simple component.

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

(*): 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

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	Introduction & demonstration of cutting tools re-sharpening	I & II	02
02	Draw production drawings of all parts of fixture (Detail Drawing).	III & IV	04
03	Draw assembly of fixture with BOM.		03
04	Draw production drawings of all parts of jig (Detail Drawing).		04
05	Draw assembly of jig with BOM.		03
06	Draw production drawings of die block, die shoe and stripper plate of progressive die.	V	04
07	To draw assembly which include punches, die, die shoe and stripper plate of progressive die.		04
08	Select & design limit gauge for given component.	VI	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**.**

II. Use only sketch-book to carry practice work as term work.

III. Production drawings include-drawings with dimensions-scale, surface finish symbols, limits/fits, tolerances, surface treatment/s, heat treatment/s and other notes/details required to manufacture the part.

IV. Assembly drawing include minimum two views (one preferably sectional view if required) and parts list i.e. Bill of Material (BOM).

V. In examination, students are required to sketch freehand only.(For all questions).

VI. 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.

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 Demonstration type PrOs (PrOs Number: 1)		
1	Knowledge	30
2	Quality of Report	30
3	Participation	20
4	Punctuality	20
Total		**100**
Design/drawing type PrOs (PrOs Number: 2 to 8)		
1	Design	30
2	Detail/Assembly Drawing	20
3	Drawing General	20
4	Participation	10
5	Punctuality	20
Total		**100**

Sample rubrics Performance Indicators for the PrOs

Demonstration type PrOs (PrOs Number: 1)					
Criteria	**%**	**5**	**4**	**3-2**	**1**
Knowledge	30%	Students give the correct answers 90% or more.	Student give the correct answers between 70-89%.	Student give the correct answers between 50-69%.	Student give the correct answers less than 50%.
Quality of Report	30%	Neat Handwriting, figure, and table. Complete labeling of figure and table.	Only formatting is improper (Location of figures/tables, use of pencil and scale).	A few required elements (labeling/ notations) are missing.	Several elements are missing (content in paragraph, labels, figures, tables).
Participation	25%	Excellent focused attention in the exercise.	Moderately focused attention on exercise.	Focused limited attention in the exercise.	Participation is minimum.
Punctuality	15%	Timely Submission.	Submission late by one laboratory.	Submission late by two laboratories.	Submission late by more than two laboratories.

Design/drawing type PrOs (PrOs Number: 2 to 8)				
Criteria	**%**	**5**	**3**	**1**
Design	30%	Select proper type of Jig/Fixture/Die and develop suitable clamp and locating system/components.	Select proper type of Jig/Fixture/Die but not idea about development of suitable clamp and locating system/ components.	Not able to select proper type of Jig/Fixture/Die and develop suitable clamp and locating system/ components.
Detail/Assembly Drawing	20%	All required parts drawings are drawn with material and dimension tolerances/ballooning & BOM.	All required parts drawings are drawn with material but sufficient dimension tolerances/ballooning & BOM are not given.	All required parts drawings are not drawn with material and dimension tolerances/ballooning & BOM.
Drawing General	20%	Drawing lines are clear and well oriented. There are almost no erasures or stray marks on the paper. Overall, the quality of the drawing is excellent.	Drawing lines are clear but not well oriented. There are smudged lines or stray marks on the paper, but they do not greatly detract from the drawing. Overall, the drawing is good.	Drawing lines are not clear and not well oriented. There are several erasures, smudged lines or stray marks on the paper, which detract from the drawing. Overall, the quality of the drawing is poor.
Participation	10%	Used time well in lab and focused attention on the exercise.	Attend the lab but did not appear very interested. Focus was lost on several occasions.	Participation was minimal OR student was hostile about participating.
Punctuality	20%	Drawing work is completed within time limit	About 70 % to 90 % of work is completed within time limit	Less than 70 % of work is completed.

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
1.	Tool and cutter grinding machine.

2.	Cutting tools, mainly set consisting assorted sizes of drill bits, set consisting assorted sizes of end mills, set consisting assorted sizes of side and face milling cutters, set consisting assorted sizes of center drills-Type A and B, assorted carbide inserts.
3.	Tool holders for carbide inserts, drill spindles/quills, milling machine quills,
4.	Most commonly used set of locators and clamping devices, jigs and fixtures.
5.	Models of jigs and fixtures.
6.	Press-2.5 to 5 Tonnes, (Hydraulic or electrical operated), set of assorted sizes punches and dies.
7.	Set of various hand tools, cutting tools, models, Different types of limit gauges.

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) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I Introduction	1.a Explain role of tool engineering in industries. 1.b Establish importance of process planning in tool engineering.	1.1 Concept, meaning and definitions of tool, tool design and tool engineering. 1.2 Tools-types, classification, features & applications. 1.3 Tool engineering-functions and importance to enhance productivity and quality. 1.4 Importance of process planning in tool engineering.

Unit– II Cutting tools and tool holders	2.a List cutting tool materials. 2.b Interpret ISO- designation for carbide inserts. 2.c Describe process for re-sharpening commonly used cutting tools. 2.d Interpret ISO- designation for tool holders for carbide inserts.	2.1 Cutting tool materials-types, composition, properties and applications. 2.2 Carbide inserts-types, ISO-designation and applications. 2.3 Re-sharpening methods of following cutting tools: a. Drill. b. Side and face milling cutter. c. End mill. d. Centre drill, type A and B. e. Gear hob. 2.4 Tool holders for turning and milling carbide inserts-types, ISO-designation and applications.
Unit-III Locating and clamping devices	3.a Explain location and 3-2-1 principle of location. 3.b Establish importance of degree of freedom in location. 3.c Select and use suitable locator for given work piece. 3.d Select and use appropriate clamping device for given work-piece situation.	3.1 Concept, meaning and definitions of location and clamping. 3.2 Use of locating and clamping principles in day-to-day supervision on shop floor. 3.3 Degree of freedom - concept and importance. 3.4 3-2-1 principle of location. 3.5 Locators & clamping devices: a. Types b. Sketches with nomenclature. c. Working. d. Applications. 3.6 Fool proofing and ejecting.
Unit– IV Jigs and fixtures	4.a Differentiate between jigs and fixtures. 4.b Select and design appropriate jig or fixture for given simple work piece.	4.1 Concept, meaning, difference and benefits of jigs and fixtures. 4.2 Types, sketches with nomenclature, working and applications of jigs & fixtures. 4.3 Steps to design jigs and fixture. 4.4 For given simple component: a. Select type (Jig or fixture). b. Develop locating method. c. Develop clamping method. d. Design jig and fixture. e. Prepare details and assembly drawing.
Unit–V Press tools	5.a Select suitable press tool 5.b operation for given simple press tool component. 5.c Calculate press tonnage and center of pressure for given press tool component. 5.d Determine dimensions of punch and die for given press tool component. 5.e Determine shear angle.	5.1 Press working processes-types, sketches and applications. 5.2 Press tools: types, working, components and their functions 5.3 Concept, meaning, definitions and calculations of press tonnage and shut height of press tool. 5.4 Shear action in die cutting operation and Centre of pressure: Concept, meaning, definition, methods of finding and importance.

	5.f Prepare scrap strip layout for given press tool component. 5.g Design progressive cutting die for given simple press tool component.	5.5 Die clearance: Concept, meaning, definition, reasons, effects and methods of application and Cutting force: Methods to calculate and methods of reducing. 5.6 Shear angle- concept, need and method to give shear angle on punch and die. 5.7 Scrap strip layout: - Concept, importance, method to prepare, and determining percentage stock utilization. 5.8 Types, working, and applications of stock stop, pilots, strippers and knockouts. Cutting dies-types and applications. 5.9 Design of progressive cutting die: a. Sketch the component. b. Prepare scrap strip layout. c. Calculate tonnage. d. Determine center of pressure. e. Determine dimensions of punches, die block and die shoe. f. Prepare sketch of stripper plate. g. General assembly sketch of h. Punches arrangement, die block, die shoe and stripper plate.
Unit–VI Dies, moulds and limit gauges	6.a Calculate bend radii, bend allowance and spring back for given Simple part. 6.b Describe working of various dies. 6.c Select type of die/mould for given part. 6.d Design limit gauges for given part.	6.1 Bending: a. Types. b. Parts and functions of bending die. c. Definition, calculations and factors affecting bend radii, bend allowance and spring back. d. Method to compute bending pressure. e. Types, sketch, working and applications of bending dies. f. Types, sketch, working and applications of drawing dies (embossing, curling, bulging, coining, swaging and hole flanging). 6.2 Classifications of Limit Gauges. Desirable properties of gauge materials. Advantages and disadvantages of Limit gauges. 6.3 List of factors to be considered in selection of gauge. 6.4 Taylor's Principle of gauge design. 6.5 Design steps for plug gauges and snap gauges.

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.	3	2	4	2	8
II	Cutting tools and tool holders.	7	4	4	4	12
III	Locating and clamping devices.	7	3	4	4	11
IV	Jigs and fixtures.	10	3	4	7	14
V	Press tools	10	4	2	8	14
VI	Dies, moulds & limit gauges	5	4	4	3	11
Total		**42**	**20**	**22**	**28**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

Sr. No.	Activity.
1.	Download the catalogues for cutting tools, jigs and fixtures and prepare report on their features and specifications.
2.	Visit nearby manufacturing unit and prepare the list with specifications of cutting tools, hand tools, press tools, measuring tools and consumables being used there.

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.

Sr. No.	Unit	Unit Name	Strategies
1	I	Introduction.	Movie, Industrial visit.
2	II	Cutting tools and tool holders.	Demonstration of physical cutting tools and tool holders.
3	III	Locating and clamping devices.	Demonstration of physical locating and clamping devices in operation, video movies,
4	IV	Jigs and fixtures.	Demonstration with operations, video movies, Industrial visits.
5	V	Press tools.	Demonstration with operations, video movies, Industrial visits.
6	VI	Dies, moulds & limit gauges.	Video movies, Industrial visits.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned 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 at least COs with in integration of PrOs, UOs, and ADOs. The duration of the micro project should be about **4-5** ***(four to five) 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. Similar micro-projects could be added by the concerned course teacher or using suggested student activity.

A representative list of micro-projects is given here. The concerned faculty can add similar micro-projects based on student activities (chart/presentation/report/model/animation):

1. Prepare individual components of Jig as per design using wood or plastic. Assemble them by using components of 3-4 student groups.
2. Prepare a tabulated summary of the types of Jig Bushes used in industry which are available in the market.
3. Prepare individual components of Fixture as per design using wood or plastic. Assemble them by using components of 3-4 student groups.
4. Prepare individual components of Progressive Die as per design using wood or plastic. Assemble them by using components of 5-6 student groups.
5. Prepare a display chart of different types of cutting tool holder.
6. Prepare a display chart of different types of material inserts.
7. Make a PowerPoint presentation on the latest industry trends in tool engineering field.
8. Prepare a tabulated summary of the types of Locators used in industry which are available in the market.
9. Prepare a tabulated summary of the types of Clamping devices used in industry which are available in the market.
10. Make a PowerPoint presentation on the latest industry trends available in cutting tool types.
11. Visit and prepare report on types of industry which have small, medium & larger size of tool room availability.
12. Prepare actual model of Plug Gauge you have designed for given component.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication
1.	Fundamentals of tool design	ASTME	PHI.
2.	Tool design.	Cyril Donaldson and George H Lecain	TME
3.	Tool engineering	Doyal.	
4.	Principles of tool & jig design	M. H. A. Kempster.	
5.	Jigs and fixture	P. H. Joshi	TMGH
6.	Design Of Jigs Fixtures and Press Tools	C. Elanchezhian, T. Sunder Selwyn, B.Vijaya Ramnath	Eswar Press, 2007, 2nd Edition
7.	Cutting tools standards.	-	BIS
8.	Production technology	-	HMT
9.	PSG Design data book	PSG, Coimbatore	PSG, Coimbatore
10.	Tool Engineering and Design"	G R Nagpal. ..	Khanna publishers
11.	Metal Cutting and Tool Design	Ashok Kumar Singh	

12.	Tool Engineering	Vilas S Teli	Nirali Prakashan
13.	Tool Engineering Die design fundamentals	Vukota Boljanovic & J R Paquin	

14. SOFTWARE/LEARNING WEBSITES

1. https://www.youtube.com/watch?v=TsCcBT6FZKw (Dual curl)
2. https://www.youtube.com/watch?v=8XOKE8cMAi4&t=82s (Progressive dies)
3. https://www.youtube.com/watch?v=LKEG3p3yx1g (combination dies)
4. https://www.youtube.com/watch?v=YuQFhbRaWD0 (comparison of forging dies)
5. https://www.youtube.com/watch?v=ECA390jloJg (Press working operations)
6. https://www.youtube.com/watch?v=jhBBEBDk4P4&t=182s (Sheet metal operations)
7. https://www.youtube.com/watch?v=QfDb8FjaqNg (Punching and blanking operations)
8. https://www.youtube.com/watch?v=9GHUQBTDC9E (Press tools)
9. https://www.youtube.com/watch?v=HVbbSl5WreA (Jigs and fixtures animation)
10. https://www.youtube.com/watch?v=J_d8IRT9r7E (Press working operations Animation)
11. https://www.youtube.com/watch?v=FaEt0q7YRFQ (Jigs and fixtures concepts)
12. https://www.youtube.com/watch?v=04V6x1fkqQs (Locating and supporting devices)
13. https://www.youtube.com/watch?v=ABAIKYyiEg0 (Jigs and fixtures for drill machine)
14. https://www.youtube.com/watch?v=5YmKwVAkZgo (Single point cutting tool)
15. https://www.youtube.com/watch?v=i0P_uELEuJw&t=14s (Types of Cutting Tools and Uses)

15. PO-COMPETENCY-CO MAPPING

Semester V	**Tool Engineering (4341905)**						
	POs						
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
Competency & Course Outcomes	Basic & Discipline-specific knowledge	Problem Analysis	Design/ development of solutions	Engineering Tools, Experimentation& Testing	Engineering practices for society, sustainability & environment	Project Management	Life-longLearning
Competency	Develop the ability to select and/or design cutting tools, tool holders, dies, jigs and fixture for given simple component.						
CO-1: Use relevant cutting tools for given manufacturing operations.	3	-	-	2	-	-	-
CO-2: Identify and select locating and clamping devices for given component.	3	2	-	-	-	-	-
CO-3: Design jig and fixture based on components' geometry and machining operations.	3	2	3	-	2	-	2
CO-4: Identify appropriate press working operations for mass production of sheet metal parts.	2	2	3	-	-	-	-
CO-5: Select and design dies and limit	2	2	-	-	2	-	2

gauges for a given simple component.							

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. Altaf Nalbandh	Government Polytechnic, Porbandar	9904230786	altaf.nalbandh85@gmail.com
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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