GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Metal Forming Processes
(Course Code: 4332105)

Diploma Programme in which this course is offered	Semester in which offered
Metallurgy Engineering	Third

1. RATIONALE

A number of metallic engineering products are used in the construction, fabrication and transportation industries. A prominent method for the production of metallic products is a forming process such as rolling, forging, extrusion, drawing etc. The curriculum is designed to introduce students to the fundamentals of the metal forming process along with metallurgical aspects. Metal forming is a basic manufacturing process, therefore, student or diploma engineers must be aware of the deformation of metals, changes in mechanical and physical properties after deformation and the basic knowledge of equipment and production of various components by a suitable process. This course aims to equip the student with the knowledge of various metalworking operations that leads to getting the best metallurgical qualities and economic products.

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 the following competency:

- **Select a suitable metal working operation for the specific application of metals and alloys.**

3. COURSE OUTCOMES (COs)

At the end of the study of this course the student will be able to:

1. Classify and differentiate metal forming processes
2. Select rolling process for manufacturing of specific products
3. Discuss various forging processes
4. Explain extrusion and drawing as metal forming processes
5. Choose miscellaneous metal forming process for specific products
6. Understand sustainability in metal forming

1. 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	1	0	4	30*	70	--	--	100

(*): 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.*

2. SUGGESTED TUTORIAL EXERCISES

Sr. No.	TUTORIALS	Unit No.	Approx. Hrs. Required
1	Discuss mechanical properties involved in metal forming processes	I	1
2	Draw the stress strain diagram for different types of materials	I	1
3	Calculate the amount of ductility for metal working operations	I	2
4	Discuss metallurgical factors involved metal forming processes	I	1
5	Classify and differentiate metal forming processes based on working temperature	I	1
6	Recognize the working parameters on metal forming processes by virtual lab and/or videos	I	2
7	Calculate a reduction ratio for rolling mill	II	2
8	Draw the schematic diagram of various rolling mills	II	1
9	Draw forging hammers and presses	III	1
10	Draw the schematic diagram of direct and indirect extrusion	IV	1
11	Select the relevant metal forming process for given products	III, IV & V	1

3. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the guide to procure them by the administrators to use in uniformity of practical in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	Tutorial No.
Not applicable		

4. AFFECTIVE DOMAIN OUTCOMES

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

1. Work as a team member / a leader.
2. Follow ethical practices.
3. Practice environmentally friendly methods and processes.

5. 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	Major Learning Outcomes	Topics and Sub-topics
UNIT – I Introduction to metal forming processes	1.a. Discuss important mechanical properties 1.b. Explain Stress-strain diagram 1.c. Describe metallurgical factors involved in metal forming processes 1.d. Discuss the importance of metal forming processes 1.e. Differentiate between hot and cold working processes 1.f. Classify metal forming processes	1.1. Mechanical properties of metal and alloys. 1.2. Stress-strain diagram for elastic and plastic materials 1.3. Metallurgical fundamentals involved in processes a. Types of deformations, b. Recovery, recrystallization and grain growth, c. Strain hardening 1.4. Introduction to forming processes and importance, Products 1.5. Types of process based on working temperatures 1.6. Forming processes: Classification, Advantages and limitations.

Unit	Major Learning Outcomes	Topics and Sub-topics
UNIT – II **Rolling process**	2.a. Discuss the importance of rolling processes 2.b. Explain theory involved in rolling processes 2.c. Discuss product manufacture by rolling process 2.d. List out defects occurred in rolled products and discuss their remedies	2.1. Introduction of rolling process 2.2. Theory of rolling, Equipment, Types of rolling mill 2.3. Manufacture of various rolled products like sheet, angle, channel 2.4. Defect in rolled products and remedies
UNIT – III **Forging process**	3.a. Discuss forging processes in detail. 3.b. Identify types of forging processes and operations 3.c. Discuss equipment involved in forging process 3.d. Understand defects occurred in forged product and discuss their remedies	3.1. Introduction of forging process 3.2. Types of forging process and operations 3.3. Forging machines / equipment 3.4. Defects in forged product and remedies
UNIT – IV **Drawing and extrusion processes**	4.a. Understand about drawing and extrusion processes in detail.	4.1. Introduction, Principle, classification, Machine / Equipment, Products, Defects and remedies for the process of: a. Drawing, b. Extrusion
UNIT – V **Sheet metal and special forming processes**	5.a. Discuss sheet metal forming processes in detail.	5.1. Introduction, classification, Machine / Equipment, Products for the process of: a. Bending, b. Deep drawing, c. Stretch forming. d. Blanking, e. Piercing, f. Slug production, g. Coining.
Unit – VI **Sustainability in metal forming industries**	6.a. Understand sustainability in metal forming industries	6.1. Factors affecting sustainability in metal forming industries

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	Introduction to metal forming processes	9	4	5	4	13
II	Rolling process	8	3	5	4	12
III	Forging process	8	3	5	6	14
IV	Drawing and extrusion processes	7	4	5	5	14
V	Sheet metal and special forming processes	9	3	5	5	13
VI	Sustainability in metal forming industries	1	1	1	2	4
	Total	**42**	**18**	**26**	**26**	**70**

Legends: *R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)*

Notes:

a) This specification table shall be treated as a general guideline for students and Teachers. The actual distribution of marks in the question paper may slightly vary from the above Table.

b) Ask the questions from each topic as per marks weightage. Numerical questions are to be asked only if it is specified. Optional questions must be asked from the same topic.

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 conduct following activities in group.

a) Visit nearby industries engaged in metal forming (if any) and study the processes are being used.

b) Create small working models of the shaping process for a better understanding of the process.

c) List out the metal products that we are using in daily life and find out which shaping process is useful for its production.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

Sr. No.	Unit Title	Strategies
I	Introduction to metal forming processes	Real life examples. Demonstration of real systems. Movies/Animations. Numerical
II	Rolling process	
III	Forging process	
IV	Drawing and extrusion processes	
V	Sheet metal and special forming processes	
VI	Sustainability in metal forming industries	

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-project are group-based. However, in the fifth and sixth semesters, it should be preferably be individually undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, 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 a dated work diary consisting of individual contributions in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than 16 (sixteen) student engagement hours during the course. The student ought to submit a 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:

1. Prepare a model of a metal forming process.
2. Prepare a datasheet for calculation of ductility or forming process.
3. Prepare a chart on metal forming process.
4. Collection of products which are manufactured by metal forming processes.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author / Editor	Publication with place, year and ISBN
1	Mechanical Metallurgy	George E. Dieter	Tata McGraw-Hill, New Delhi, India, 2012 (ISBN: 0-07-100406-8)
2	Handbook of Metal Forming	Kurt Lange	Society of Manufacturing Engineers, Michigan, USA, 1985 (ISBN: 0-87263-457-4)
3	Technology of Metal Forming Processes	Surender Kumar	PHI Learning,New Delhi, India, 2008 (ISBN: 978-81-203-3425-0)
4	Manufacturing Technology, Volume 1 (Foundry, Forming and Welding)	P. N. Rao	McGraw-Hill, New Delhi, India, 2013 (ISBN: 978-1-25- 906257-5)
5	Engineering Metallurgy: Part II	R. A. Higgins	Hodder and Stoughton, London, England, 1976 (ISBN:9780340185063)
6	Metal Process Engineering	P. Polukin, B. Gringerg, S. Kantenik, V. Zhadan and D. Vasilye	MIR Publishers, Moscow, Russia 1977

14. SOFTWARE/LEARNING WEBSITES

1. http://msvs-dei.vlabs.ac.in/msvs-dei/
2. https://nptel.ac.in/courses/112107250
3. https://youtu.be/aQf6Q8t1FQE
4. https://youtu.be/Um_g8sQ_p3Y
5. https://www.altair.com/newsroom/partner-perspectives/sustainability-in-metal-forming/

15. PO-COMPETENCY-CO MAPPING

Semester III	Metal Forming Processes [Course Code: 4332105]						
	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	**Select a suitable metal working operation for the specific application of metals and alloys.**						
Course Outcomes: CO 1) Classify and differentiate metal forming processes	3	-	1	-	-	-	-
CO 2) Select rolling process for manufacturing of specific products	3	-	2	1	-	-	1
CO 3) Discuss various forging processes	3	-	2	1	-	-	1
CO 4) Explain extrusion and drawing as metal forming processes	3	-	2	1	-	-	1
CO 5) Choose miscellaneous metal forming process for specific products	3	-	2	1	-	-	1
CO 6) Understand sustainability in metal forming	3	1	-	-	3	-	1

*Legend: '**3'** for high, '**2**' for medium, **'1'** for low or **'-'** for the relevant correlation of each competency, CO, with PO/ PSO*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons:

Sr. No.	Name and Designation	Institute	Email
1	Mr. Yakshil B. Chokshi, Lecturer Metallurgy	Government Polytechnic, Rajkot	yakshil.chokshi@gmail.com
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