GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Sheet Metal Fabrication
(Course Code: 4345502)

Diploma programmer in which this course is offered	Semester in which offered
Fabrication Technology	4th Syllabus

1. RATIONALE

This course provides the knowledge and practice regarding different sheet metal fabrication techniques. This course gives hands on practice regarding development, cutting and forming of different sheet metal components. This course gives knowledge and practice of temporary and permanent joining of sheet metal. This course gives knowledge about different major industrial sheet metal work application.

2. COMPETENCY

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

- **Fabricate different sheet metal components by using appropriate sheet metal joining process**

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) Prepare pattern development for given job.
b) Prepare Gas welding procedure for a given job.
c) Prepare soldering and brazing procedure for a given job.
d) Use appropriate resistance welding process for a given job.
e) Select fastener for making sheet metal joint for given application.

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	
4	0	2	6	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.*

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Study safety precaution for sheet metal workshop.	1	02
2	Identify and draw different hand tools used in sheet metal work.	1	02
3	Prepare Pattern Development of Box using drawing sheet.	1	02
4	Prepare Pattern Development of Hopper using drawing sheet.	1	02
5	Prepare Pattern Development of Funnel using drawing sheet.	1	02
6	Prepare Pattern Development of Liter Cane using drawing sheet.	1	02
7	Prepare Pattern Development of AC Duct using drawing sheet.	1	02
8	Prepare one Sheet Metal job from galvanized sheet for object from exercise 1 to 6 (individually or in a group) as per given specification.	1,4	04
9	Demonstrate Soldering operation on a given job.	2	02
10	Demonstrate Brazing process on a given job.	2	02
11	Demonstrate Gas welding operation on a given job.	3	02
12	Perform Resistance Spot welding operation on given job.	4	02
13	Draw riveted joints and screw thread terminology and different types of thread.	5	02
14	Prepare Pattern Development of dust pan using drawing sheet.	01	02*
15	Prepare Pattern Development of Three Piece Elbow using drawing sheet.	01	02*
16	Draw sheet metal working operations with neat sketch.	01	02*
	TOTAL HOURS.		**28**

**marked practical are extra practical can be included as per the available time hours which depends on the concern faculty of the course.*

Note

i. *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.*
ii. *Boiler suit, safety shoes & other safety items are compulsory while attending laboratory and has to be brought by students. (annexure-1)*

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 PrOs no: 2,13,16		
1	Knowledge.	20
2	Drawing Layout, Planning & Scale	20
3	Neatness & completeness	30
4	Dimensions (accuracy)	20
5	Punctuality	10
Total		**100**

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
For PrOs no: 3 to 8,14,15		
1	Knowledge of experiment	20
2	Performance	30
3	Procedure followed	30
4	Quality of report	10
5	Punctuality	10
Total		**100**

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
For PrOs no: 1,9,10,11,12		
1	Knowledge of experiment	30
2	Quality of report	30
3	Participation	20
4	Punctuality	10
5	Originality	10
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipment with broad specifications for the PrOs are guide to procure them by the administrators to user in uniformity of practical's in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1.	Drawing set, fevicol (glue),scissor, ruler, etc.	3,4,5,6,7
2.	Hand gloves, Safety goggles, Hand sleeve, Leg guard etc.	9,10,11
3.	Tri square, Scriber, Bench vice, caliper, Fix spanners, Ring spanner, Adjustable spanner, Plyer, Lock Plyer, Adjustable plyer, Compass, Divider, etc.	8
4.	Oxygen cylinder, Acetylene cylinder, Oxygen cylinder regulator, Acetylene cylinder regulator, Hose pipe, Oxy fuel cutting torch, Ignitor, Back fire arrestor etc.	10,11
5.	Resistance spot welding machine, Resistance seam welding machine, Resistance upset butt welding machine, Resistance percussion welding machine.	12
6.	Soldering iron, soldering consumable, heater to melt soldering consumable, soldering torch kit .	9

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) Follow safety practices in laboratory.
b) Practice good housekeeping.
c) Work as a leader/a team member.
d) Maintain tools/equipment
e) Follow ethical practices

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& 4th 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)	Topics and Sub-topics
Unit-I Sheet Metal working and operations	1a. Understand the profile of sheet metal shop supervisor 1b. Use hand tool required in sheet metal work 1c. Prepare the pattern development of the given job 1d. Describe the press tool dies 1e. Describe the defects in sheet metal formed parts	1.1 Importance ofsheet metal fabrication 1.2 Knowledge, skill and attitude required for sheet metal fabricationsupervisor 1.3 Metal used in sheet metal work 1.4 Sheet metal hand tools 1.5 Sheet metal joints : Hems, seams and notches 1.6 Sheet metal allowance 1.7 Sheet metal working machine 1.8 Sheet Metal Pattern development 1.9 Introduction of press work 1.10 Construction & types of press 1.11 Selection and specification of a press 1.12 Different types of press working dies 1.13 Cutting or shearing process 1.14 Press tool operations 1.15 Spring back 1.16 Stock layout 1.17 Defects in sheet metal formed parts 1.18 Safety while working in sheet metal shop 1.19 Sheet metal work applications
UNIT– II Gas Welding	2a. Use the gas welding equipment. 2b. Prepare the welding procedure for gas welding. 2c. Identify the oxy acetylene flames types. 2d. Describe the gas welding safety recommendations.	2.1 Definition & principle of operation 2.2 Types of gas welding flames 2.3 Chemistry of oxy-acetylene flame 2.4 Flame ignition, flame adjustment and flame extinguish 2.5 Gas welding techniques 2.6 Gas welding filler metal and fluxes 2.7 Gas welding equipment 2.8 Advantages, disadvantages and applications of gas welding 2.9 Gas welding safety recommendations
UNIT– III Soldering and Brazing Process	3a. Prepare soldering procedure 3b. Prepare brazing procedure 3c. State the advantages & disadvantages of brazing process 3d. Compare soldering, brazing and welding process	3.1 Soldering process 3.1.1 Definition & principles of good soldering process 3.1.2 Soldering joint design 3.1.3 Soldering alloys (solders) and fluxes 3.1.4 Cleaning the base metal surface 3.1.5 Soldering methods 3.1.6 Soldering of various metals 3.2 Brazing Process 3.2.1 Definition and principle of operations 3.2.2 Brazing procedure 3.2.3 Brazing joint design 3.2.4 Brazing of various metals

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
		3.2.5 Brazing filler metals and fluxes 3.2.6 Advantages, limitation andapplications of brazing 3.3 Comparison of soldering, brazing and welding
UNIT– IV Resistance Welding processes	4a. Describe the electric resistance welding variables. 4b. Describe the various resistance welding processes. 4c. Compare ERW and HFW of tubes 4d. Describe resistance welding defects	4.1 Definition and fundamentals of electric resistance welding 4.2 Variable in resistance welding 4.3 Advantages, disadvantages and applications of resistance welding. 4.4 Spot welding 4.5 Seam welding 4.6 Projection Welding 4.7 Upset butt welding 4.8 Percussion welding 4.9 Resistance welding of tubes (ERW) 4.10 High frequency welding of tubes 4.11 Resistance welding defects
Unit -V Mechanical Fastening of sheet Metal	5a. Identify the types of fasteners 5b. Describe riveted joints 5c. Identify the riveted joints 5d. Identify different types of screws & bolted joint 5e. Compare riveting and welding	5.1 Types of fasteners 5.2 Riveting: introduction, advantages, application of riveting, types of rivets, types of riveted joints, defects in riveted joints. 5.3 Screwed joints 5.4 Bolted joints 5.5 Compare riveting and welding

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	Sheet Metal working and operations	18	7	14	7	28
II	Gas Welding	12	4	10	0	14
III	Soldering and Brazing Process	10	3	7	0	10
IV	Resistance Welding processes	12	3	11	0	14
V	Mechanical Fastening of sheet Metal	04	0	04	0	04
	TOTAL	**56**	**17**	**46**	**7**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*
Note: *This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks and marks at different taxonomy levels (of R, U and A)in the question paper may vary slightly 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 in group and prepare reports/charts for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Prepare solutions of different assignments given by subject faculty.
b) Prepare a list of specifications for various tools/equipment/machines used in sheet metal work.
c) Visit the local gas welder and make a report on it / sheet metal working industry.
d) Collect videos, animation showing sheet metal operation.
e) Prepare power point presentation on soldering, brazing and gas welding. .

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) Arrange visit to nearby industries and workshops or use of videos/animations for understanding various fabrication processes.

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 eighth 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. Prepare charts of different screw threads
b. Collect samples of different fasteners used for sheet metal work and prepare its chart.
c. Prepare chart of different sheet metal hand tools.
d. Draw different riveted joints
e. Prepare chart of safety rules to be followed for gas welding and handling of gas cylinders
f. Prepare the chart of different oxy acetylene flames.
g. Prepare the chart of forward and backward gas welding
h. Prepare a model of shell in which make a nozzle cut out and enlist the procedure of it.
i. Prepare a video of making pattern development of any object.
j. Make a list of the any ten products and enlist the sheet metal operation performed on it.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Production technology vol 1 & 2	O.P.Khanna & M.Lal	Dhanpat rai & sons
2	Manufacturing Technology	P.N.Rao	Tata mcgrawhill publishing co. ltd
3	Sheet metal practice	Audels	AUDEL Series
4	Welding Technology	O.P.Khanna	Dhanpat rai & sons
5	Machine design	R.S.Khurmi	Eurasia publication house
6	Workshop Technology vol 1 & 2	Hajra chaudhri	Media promoters & publishers pvt. Ltd.

14. SOFTWARE/LEARNING WEBSITES

https://nptel.ac.in/courses/112103263
https://nptel.ac.in/courses/113106087
https://www.youtube.com/watch?v=95rgHM58dgw
https://www.youtube.com/watch?v=UbliMiADZ40
https://www.youtube.com/watch?v=Pw02sYZVEac
https://www.youtube.com/watch?v=L0YgSmfwzWY
https://www.youtube.com/watch?v=jhBBEBDk4P4
https://www.youtube.com/watch?v=R5A93IAEyXo
https://www.youtube.com/watch?v=O7WvzU3FQ5c
https://www.youtube.com/watch?v=pG3UFnIYSeI
https://www.youtube.com/watch?v=ghPfvIPWVNQ
https://www.youtube.com/watch?v=uDidTD2pdK0

15. PO-COMPETENCY-CO MAPPING

Semester IV	SHEET METAL FABRICATION (Course Code:4345502)						
	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	• **Fabricate different sheet metal components by using appropriate sheet metal joining process**						
Course Outcomes co 1) Prepare pattern development for given job.	3	2	2	2	-	1	2
co 2) Prepare the Gas welding procedure for a given job.	3	-	-	1	1	-	1
co 3) Prepare soldering and brazing procedure for a given job.	3	-	-	1	-	-	1
co 4) Use appropriate resistance welding process for a given job	3	-	-	1	-	-	1
co 5) Select fastener for making sheet metal joint for given application.	2	-	-	-		-	1

*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 PersonsS. No.	Name and Designation	Institute	Contact No.	Email
1.	Mr. Samir Y.Merchant I/C. H.O.D. Fabrication Technology department	Sir Bhavsinhji Polytechnic Institute Bhavnagar	9428408314	symerchant72@gmail.com
2.	Mr. Nilesh M. Bhangale Lecturer Fabrication Technology department	Sir Bhavsinhji Polytechnic Institute Bhavnagar	9016926792	nileshbhangalefabtechbpi@gmail.com
3.	Mr. Parthiv T.Trivedi Lecturer Fabrication Technology department	Sir Bhavsinhji Polytechnic Institute Bhavnagar	9924185501	trivediparthivbpti@gmail.com

ANNEXURE-1

❖ SAMPLE SEFTY CONTRACT:

(To be filled by the students and submitted to concerned faculty/staff)

-- Use for reference purposes only --

1. You have to read and sign the safety contract.
2. The safety contract says that you understand that safety is your responsibility.
3. The safety contract to be signed before you carry out any work in the laboratory and if you don't observe and obey the safety rules, you will not be allowed in the laboratory.

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Safety Contract

Date: ______________

Name of Institute: ____

Name of Course with Code: Sheet Metal Fabrication 4345502

Name of Faculty/Staff with Designation: 1. _______________________________________

2. _______________________________________

3. _______________________________________

I RECOGNIZE THAT:

1. Safety is my responsibility while using any tool or equipment.
2. Safety regulations have been provided to me.
3. The possibility of accident and injury increases if I do not follow all the safety guidelines.
4. I must act responsibly to ensure my own safety & the safety of others in the work area.

I AGREE TO:

1. Never work in the shop without my faculty's/instructor's supervision.
2. Read and practice all the safety regulations that have been distributed to me in this course or have been posted in the work areas.
3. Act in a responsible manner at all times in the laboratory.
4. Follow all instructions given by the faculty.
5. Immediately report any unsafe condition or activity to my faculty.
6. Wear eye protection at all times when working with tools or working anywhere near someone who is using tools.
8. Cut or Tie back long hair, remove jewellery, secure loosed clothing, and wear boiler suit & safety shoes in the laboratory.
9. Clean all work areas and put equipment away before leaving the laboratory.

I, ____, have read and agree with all the safety instructions.

Particulars:

Programme: _______________________ Student Signature

Batch No.: _______________________ _________________________

Enrollment No.: ___________________