

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Semester-III

Course Title: Welding Technology-1

(Course Code: 4335503)

Diploma programmer in which this course is offered	Semester in which offered
Fabrication Technology	Third

1. RATIONALE

Welding is one of the leading manufacturing process which is extensively used in fabrication industries. A fabrication engineer has to work in the field of production, operation and maintenance of fabrication, chemical & petrochemical industries. It is necessary for the fabrication engineer to have in depth knowledge of most advance metal joining process like welding. This subject develops capability to understand the art and science of welding. The main focus of this subject is to give in depth knowledge about most widely used arc welding processes like SMAW & SAW. The students become capable to select appropriate welding power source & electrodes for these processes. This subject develops quality consciousness regarding production of sound weld joint for different fabrication applications. This is key course for fabrication engineers. This course develops safety consciousness in student during working in welding shop/laboratory.

2. COMPETENCY

The course content is leading to the achievement of the following competency:

- **Prepare a weld joint as per given specification by using SMAW/SAW process with appropriate selection of welding power source, weld joint, weld position, electrodes/flux, welding parameters and identify different defects in it.**

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) Draw a weld joint with nomenclature and welding position for given welding process.
- b) Select suitable equipment and electrodes for SMAW & SAW processes.
- c) Use shielded metal arc welding process for a job as per given specification.
- d) Use submerged arc welding process for a job as per given specification.
- e) Describe different factors affecting weld bead geometry.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	CA	ESE	CA	ESE	
4	0	4	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	Demonstrate various personal protective equipments.	1	02
2	Demonstrate safe operating procedure for arc welding.	1	02
3	Identify different arc welding equipments with their specification.	2	02
4	Identify different arc welding tools & accessories with their Specification.	2	02
5	Select SMAW electrodes as per process requirement.	2	02
6	Draw different weld joint design.	1	02
7	Draw different types of weld joint symbols.	1	02
8	Draw different types of weld position.	1	02
9	Demonstration of welding power source and arc initiation in SMAW process.	2,3,5	02
10	Perform SMAW process on given job in 1G position (flat) which includes plate cutting, marking, weld edge preparation, tacking, welding operations.	3	08
11	Perform SMAW process on given job in 2G position (horizontal) which includes plate cutting, marking, weld edge preparation, tacking, welding operations.	3	08
12	Perform SMAW process on given job in 3G position (vertical) which includes plate cutting, marking, weld edge preparation, tacking, welding operations.	3	08
13	Perform SMAW process on given job in 4G position (overhead) which includes plate cutting, marking, weld edge preparation, tacking, welding operations in a group.	3	04
14	Perform SMAW process on given job in 5G position (circular) which includes pipe/shell cutting, marking, weld edge preparation, tacking, welding operations in a group.	3	04
15	Prepare SAW job as per given specification in a group.	4	04
16	Identify different welding defects and suggest its remedies.	3,4	02
TOTAL HRS.			56

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 and necessary hand tools & instruments are compulsory while attending laboratory and has to be bought 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 PrOsno: 6,7,8		
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: 10 to 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: 1,2,3,4,5,9,16		
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 is a guide to procure them by the administrators to use in uniformity of practical's in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1.	Hand gloves, Welding face guard, Safety goggles, Hand sleeve, Leg guard etc.	1 to 4 & 9 to 15

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
2.	Welding transformer three phase, Welding motor generator	3
3.	Welding rectifier three phase, Invertor type power source	3, 9 to 15
4.	Welding electrodes/consumables	5
5.	Submerged arc welding machine	3,15
6.	Tri square, Scriber, Hacksaw blade& frame, Flat files, Hand files, Half round file, Triangular file, Rough files, Smooth files, Bevel protractor, Hammer, Chisels, Bench vice, C-clamp, Power cable, Earthing clamp, Electrode holder, chisels, Wire brush, Chipping hammer, Tong tester, Speed glass, Digital weighing scale etc.	4, 9 to 14

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 Introduction to welding	1a. Describe importance of arcwelding in fabrication industries. 1b. Classify welding processes. 1c. Describe different types of weld joints 1d. Compare welding process to other manufacturing processes.	1.1 Introduction of welding 1.2 Definition of welding 1.3 Classification of welding 1.4 Advantages & Disadvantages of welding. 1.5 Welding v/s Casting v/s Riveting 1.6 Application of welding 1.7 General safety consideration in welding 1.8 Weld joint nomenclature 1.9 Welding symbol

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
		1.10 Welding position (as per applicable code & standards in fabrication industry)
UNIT– II Arc welding equipments and electrodes	2a. Identify different types of arc welding equipment. 2b. Describe working of different welding equipment. 2c. Describe Specifications of different welding equipment. 2d. Select welding electrodes for SMAW & SAW process.	2.1 Introduction 2.2 Arc welding power source 2.3 Selection factor for power source 2.4 DC power source 2.4.1 DC generator set 2.4.2 AC DC rectifier 2.4.2.1 Constant current characteristics 2.4.2.2 Constant voltage characteristics 2.4.3 Thyristor controlled rectifier 2.4.3.1 Transistorized system 2.4.3.2 Invertor system 2.5 AC power source 2.5.1 AC generator 2.5.2 AC transformer 2.6 Other equipment required for arc welding e.g., cable, connections, holders etc. 2.7 Definition of welding electrodes 2.8 Classification of welding electrodes 2.9 Electrode shape, Polarity and its effect 2.10 Consumable electrodes 2.11 Classification & coding of consumable electrodes 2.12 Electrode coating, ingredients and their function 2.13 Selection of welding electrodes 2.14 Care and storage of welding electrodes
UNIT– III Shielded metal arc welding (SMAW)	3a. Describe principle of SMAW. 3b. Identify tools/equipments used for SMAW process. 3c. Identify defects & suggest its remedies for SMAW. 3d. Draw different type of edge preparation for butt joint. 3e. Demonstrate different arc weaving techniques.	3.1 Definition 3.2 Principle of operation 3.3 Typical edge preparation for butt joint 3.4 Striking (ignition) method 3.5 Relationship between electrode diameter and welding current 3.6 Weaving technique 3.7 Advantages, limitations and applications of SMAW process 3.8 Quality in welding 3.9 QA v/s QC 3.10 Weld quality & weld defects
Unit -IV Submerged arc welding (SAW)	4a. Explain principle of SAW. 4b. Identify tools/equipments used for SAW process. 4c. Explain different variables used in SAW. 4d. Compare SMAW with	4.1 Definition 4.2 Principle of operation 4.3 Operation/Procedure 4.4 Equipment 4.4.1 Wire feed unit 4.4.2 Trolley travel

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
	SAW. 4e. Describe importance of weld backing in SAW process.	4.5 Joint preparation 4.6 Weld backing 4.7 Advantages, Disadvantages and application 4.8 Compare SMAW with SAW
Unit -V Arc physics	5a. Describe arc initiation, structure & mechanism. 5b. Describe arc characteristics. 5c. Identify factors affecting arc blow & suggest its remedies. 5d. Describe metal transfer. 5e. Explain weld bead geometry.	5.1 Introduction of arc physics 5.2 Welding arc definition, Initiation, Structure, Mechanism 5.3 Arc Characteristics 5.3.1 Volt-amp characteristics 5.3.2 Volt-arc length characteristics 5.4 Arc stability 5.5 Arc blow: definition, factors affecting, types, mechanism, effects, and remedies 5.6 Metal transfer & its types 5.7 Weld bead geometry

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 welding	10	4	9	0	13
II	Arc welding equipments and electrodes	10	3	7	3	13
III	Shielded metal arc welding (SMAW)	12	4	7	4	15
IV	Submerged arc welding (SAW)	12	4	7	4	15
V	Arc physics	12	4	7	3	14
	TOTAL	56	19	37	14	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:

- Prepare solutions of different assignments given by subject faculty.
- Prepare a list of specifications for various tools/equipment/machines used in the arc welding.
- Visit the local metal trader/ fabricator and collect all relevant information regarding SMAW electrodes and prepare the detail report on it.

- d) Download videos showing correct practices for shielded metal arc welding & submerged arc welding processes.
- e) Student will visit the respective discipline industry / site and will prepare the list of welding technology related equipment/machineries used by that industry / site.
- f) Prepare a chart on various joint designs/weld symbols/weld positions.
- g) Collect some industrial weld component, identify type of weld in it & justify welding process used to manufacture that component.
- h) Collect videos, animation showing arc physics.
- i) Prepare power point presentation on SMAW or SAW process.

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 assessed using different assessment methods.
- e) With respect to **section No.10**, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.

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 chart regarding safety precautions for arc welding work.
- b) Draw different joints used for structural fabrication.
- c) Prepare chart of illustration of welding symbols.
- d) Prepare special tools/projects/fixtures/models using arc welding.
- e) Prepare a typical programme used for arc welding in Microsoft excel or suitable software.

- f) Survey/Visit nearby vendor, prepare sample specifications of manual metal arc welding equipments.
- g) Maintenance of available infrastructure related to fabrication i.e., welding equipments, benches, stool, table, doors, grills, solar structure etc.,
- h) Prepare a power point presentation on the topic given by the subject teacher.
- i) Prepare report using different books, technical magazine, journals etc. on the topic given by the subject teacher within the syllabus or beyond the syllabus.
- j) prepare his/her video on demonstrating different arc welding equipments, shielded metal arc welding, submerged arc welding, arc physics etc. given by the subject teacher.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Welding Technology	Dr. O.P. Khanna	DHANPATRAI PUBLICAITONS
2	Welding Processes and Technology	Dr. R.S. Parmar	KHANNA PUBLISHERS ISBN:81-7409-126-2
3	Welding Engineering and Technology	Dr. R.S. Parmar	KHANNA PUBLISHERS ISBN:81-7409-028-2
4	Modern Arc Welding Technology	S.V. Nadkarni	Oxford & IBH Publishing co., Latest edition
5	Welding Technology for Engineers	Baldev Raj, V Shankar, A K Bhaduri	Narosha Publishing House ISBN:978-81-7319-607-2
6	Welding Technology & Design	V.M. Radhakrishnan	New age international publisher ISBN (10): 81-224-1672-1 ISBN (13): 978-81-224-1672-5
7	Welding and Welding Technology	Richard L Little	Tata McGraw-Hill Publishing Company Limited ISBN: 0-07-099409-9
8	Welding	A.C. Davies	CAMBRIDGE UNIVERSITY PRESS (Tenth Edition) ISBN:0 521 56702 5
9	Material Science & Technology	Dr. O.P. Khanna	DHANPATRAI PUBLICAITONS

14. SOFTWARE/LEARNING WEBSITES

- <https://www.aws.org>
- <https://iiwindia.com>
- <https://www.britannica.com/technology/welding>
- <https://weldingproductivity.com/>
- <https://www.thefabricator.com/thewelder/about>
- <https://weldguru.com/welding-processes/>
- <https://www.welding-world.com/>
- <https://www.lincolntech.edu/news/skilled-trades/welding-technology/types-of-welding-procedures>
- <https://www.themanufacturer.com/articles/different-types-of-welding-and-what-they-are-used-for/>
- <https://youtube.com/playlist?list=PLwdnzIV3ogoUQnGO8eFFygVBTjF0xyYMq>

- <https://www.youtube.com/watch?v=K-nJlqnmAfw&t=219s>
- <https://www.youtube.com/watch?v=Zc3Fu1AVCjc>

15. PO-COMPETENCY-CO MAPPING

Semester II	Welding Technology-1 (Course Code:4335503)						
	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	<ul style="list-style-type: none"> • Prepare a weld joint as per given specification by using SMAW/SAW process with appropriate selection of welding power source, weld joint, weld position, electrodes/flux, welding parameters and identify different defects in it. 						
Course Outcomes							
CO 1) Draw a weld joint with nomenclature and welding position for given welding process.	3	2	-	-	-	-	1
CO 2) Select suitable equipment and electrodes for SMAW & SAW process.	3	2	-	2	-	-	2
CO 3) Use shielded metal arc welding process for a job as per given specification.	3	2	-	1	-	-	2
CO 4) Use submerged arc welding process for a job as per given specification.	3	1	-	1	-	-	2
CO 5) Describe different factors affecting weld bead geometry.	3	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 Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Mr. Samirbhai Y. Merchant	Sir Bhavsinhji Polytechnic Institute Bhavnagar	9428408314	symerchant72@gmail.com
2.	Mr. Ashoksinh M. Gohil	Sir Bhavsinhji Polytechnic Institute Bhavnagar	9924682010	amgohilges@gmail.com
3.	Mr. Nilesh M. Bhangale	Sir Bhavsinhji Polytechnic Institute Bhavnagar	9016926792	nmbhangale@gmail.com
4.	Mr. Kapilkumar B. Pipavat	Sir Bhavsinhji Polytechnic Institute Bhavnagar	9427343525	Kapil.pipavat@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.

.....

Safety Contract

Date: _____

Name of Institute: _____

Name of Course with Code: Welding Technology-1 (4335503)

Name of Faculty/Staff with Designation: 1. _____

2. _____

3. _____

I RECOGNIZE THAT:

1. Safety is my responsibility when using a tool.
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/instructor.
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.: _____