GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name : Diploma Engineering
Level : Diploma
Branch : Fabrication Technology
Subject Code: DI04055051
Subject Name : Welding Technology - 2

w.e.f. Academic Year:	2025-26
Semester:	4th
Category of the Course:	Professional Elective - I

Prerequisite:	-
Rationale:	Welding is a leader of today's high-tech approach to manufacturing. Because of its versatility and simplicity, it is particularly dominant in the maintenance and repair industries, and is heavily used in the construction of steel structures and in industrial fabrication. As the pass out student will have to work in the field of production, operation and maintenance of fabrication, chemical & petrochemical industries so, it is necessary for the student to learn different welding techniques, equipment and tools. By undergoing learning experiences under this subject, students will understand the theoretical and practical aspects of various welding processes. Students will be conversant with the application of relevant standards & codes, operation and maintenance of different welding equipment like welding transformers, welding rectifiers etc. Thus it is very important course for fabrication engineers.

Course Outcomes:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Prepare set-up of GMAW process variants for given job.	A
02	Describe GTAW & PAW welding processes.	U
03	Describe ESW, Stud & LBM welding processes.	U
04	Describe dissimilar metal welding, hardfacing of materials & welding jigs and fixture.	U
05	Interpret PQR, WPS and WPQ format as per ASME section-IX.	A

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+(PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial/ Practical		
L	T	PR	C	ESE (E)	PA (M)	PA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**GMAW Welding Processes Variants** 1.1 Classification of welding processes 1.2 Gas Metal Arc Welding (GMAW) or Metal Inert Gas (MIG) Welding 1.2.1 Definition 1.2.2 Principle of operation 1.2.3 Welding parameters for different materials 1.2.4 Welding equipment 1.2.5 Different metals welded 1.2.6 Joint design 1.2.7 Advantages, disadvantages & applications 1.3 CO_2 Welding or Metal Active Gas (MAG) Welding 1.3.1 Definition 1.3.2 Principle of operation 1.3.3 Welding equipment 1.3.4 Welding variables and parameters 1.3.5 Joint design 1.3.6 Welding procedure 1.3.7 Advantages, disadvantages & applications 1.4 Flux Cored Arc Welding (FCAW) 1.4.1 Definition and concept 1.4.2 Principle of operation 1.4.3 Welding equipment 1.4.4 Weldable metals 1.4.5 Joint design 1.4.6 Welding parameters	10	22.22

	1.4.7 Flux cored electrode wire and its functions 1.4.8 Advantages, limitations & applications		
2.	**GTAW & PAW Welding Processes** 2.1 Gas Tungsten Arc Welding (GTAW) or Tungsten Inert Gas (TIG) Welding 2.1.1 Definition 2.1.2 Principle of operation 2.1.3 Welding parameters for different materials 2.1.4 Welding equipment 2.1.5 Base metals welded 2.1.6 Joint design 2.1.7 Advantages, disadvantages & applications 2.2 Plasma Arc Welding (PAW) 2.2.1 Definition and concept 2.2.2 Principle of operation (a) Non-transferred arc process (b) Transferred arc process 2.2.3 Equipment 2.2.4 Process description 2.2.5 Welding parameters for different metals 2.2.6 Base metals welded 2.2.7 Joint design 2.2.8 Backing requirement 2.2.9 Comparison between PAW and TIG welding 2.2.10 Advantages, disadvantages & applications	8	17.78
3.	**ESW, Stud & LBM Welding Processes** 3.1 Electroslag Welding (ESW) 3.1.1 Definition and concept 3.1.2 Principle of operation 3.1.3 Conventional electroslag welding 3.1.4 Consumable guide electroslag welding 3.1.5 Welding equipment 3.1.6 Joint preparation 3.1.7 Welding parameters for different plate thicknesses 3.1.8 Advantages, disadvantages & applications 3.2 Stud Welding 3.2.1 Definition and concept 3.2.2 Classification 3.2.3 Principle of operation (a) Non-conductor ferrule method	12	26.67

	(b) Semi-conductor cartridge method 3.2.4 Equipment 3.2.5 Stud welded metals 3.2.6 Advantages, limitation & applications 3.3 Laser Beam Welding (LBW) 3.3.1 Definition & concept 3.3.2 Principle & theory of Operation 3.3.3 Forms of laser 3.3.4 Joint design 3.3.5 Advantages, disadvantages & applications 3.3.6 Safety aspect		
4.	**Dissimilar metal welding, Hardfacing & Jigs-Fixture** 4.1 Welding of Dissimilar Metal 4.1.1 Concept of dissimilar metal welding 4.1.2 Techniques for dissimilar metal welding 4.1.3 Welding various dissimilar metals combinations 4.2 Hardfacing of materials 4.2.1 Definition and concept 4.2.2 Objectives of hardfacing 4.2.3 Types of surfacing (cladding, hardfacing, built up, buttering) 4.2.4 Principle of operation, steps involved 4.2.5 Hardfacing alloys 4.2.6 Base metals 4.2.7 Surfacing methods 4.3 Welding Jigs and Fixture 4.3.1 Introduction 4.3.2 Welding Jigs 4.3.3 Welding Fixtures 4.3.4 Consideration in fixture selection 4.3.5 Principles governing design of good welding jigs and fixtures 4.3.6 Various types of Jigs and Fixtures	8	17.78

5.	**PQR, WPS, & WPQ and Welding Variables** 5.1 Introduction of ASME Sec-IX 5.2 Definition of code & standard 5.3 Definition of PQR, WPS, & WPQ 5.4 Welding variables for SMAW, SAW, GMAW and GTAW processes (Essential, Supplementary- Essential and Non-Essential) 5.5 Interpretation of Procedure Qualification Record (PQR) 5.6 Interpretation of Welding Procedure Specification (WPS) 5.7 Interpretation of Welder Performance Qualification (WPQ) 5.8 Difference between WPS and PQR 5.9 Type of Tests Required for PQR and WPQ 5.10 Welder position qualification table	07	15.56
	Total	**45**	**100.00**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
38 %	50 %	12 %	-	-	-

Where R:Remember;U:Understanding; A:Application, N:Analyze and E:Evaluate; C:Create (as per 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.*

References/Suggested Learning Resources:
(a) Books:

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Welding Technology	Dr. O.P. Khanna	Dhanpatrai Publications
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	Baldev Raj,	Narosha Publishing House ISBN:978-81-

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
	Engineers	V Shankar, A K Bhaduri	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 Publications
10	ASME Code Sec-IX	ASME	ASME

(b) Open-source software and website:

1. https://www.aws.org
2. https://iiwindia.com
3. www.lincolnelectric.com
4. www.esab.com
5. www.pwsweld.com
6. https://www.fronius.com/en-in/india
7. www.asme.org
8. https://www.thefabricator.com/thewelder/about
9. https://weldguru.com/welding-processes/
10. https://www.welding-world.com/
11. https://www.lincolntech.edu/news/skilled-trades/welding-technology/types-of-welding-procedures
12. https://www.themanufacturer.com/articles/different-types-of-welding-and-what-they-are-used-for/
13. https://youtube.com/playlist?list=PLwdnzlV3ogoUQnGO8eFFygVBTjF0xyYMq
14. https://www.youtube.com/playlist?list=PLyqSpQzTE6M-KwjFQByBvRx464XpCgOEC
15. https://www.youtube.com/playlist?list=PLbMVogVj5nJSjLB85-HKhw1aCIBxn3pWj
16. https://www.youtube.com/playlist?list=PLwdnzlV3ogoW9g44SFbiiCjyMOMPnNBL8
17. https://www.youtube.com/playlist?list=UULFNsevwV4DudhNrePQGWKADA
18. https://www.youtube.com/playlist?list=PLD7A954517F4AE47A

Suggested Course Practical List:

Sr. No.	List of Practical	No. of Hours
1	Prepare list of tools, equipment and accessories used in welding laboratory with their Specification.	02
2	Demonstrate welding operation using speed glass welding screen.	02
3	Measure OCV, CCV and Ampere using Clamp (TONG) tester.	02
4	Demonstrate GMAW welding process on mild steel job which includes plate cutting, marking, weld edge preparation, welding process set-up, tacking, welding operations, etc.	02
5	Demonstrate FCAW welding process on mild steel job which includes plate cutting, marking, weld edge preparation, welding process set-up, tacking, welding operations, etc.	02
6	Demonstrate GTAW welding process on mild steel job which includes plate cutting, marking, weld edge preparation, welding process set-up, tacking, welding operations, etc.	02
7	Demonstrate GTAW welding process on stainless steel job which includes plate cutting, marking, weld edge preparation, welding process set-up, tacking, welding operations, etc.	02
8	Demonstrate GTAW welding process on aluminium job which includes plate cutting, marking, weld edge preparation, welding process set-up, tacking, welding operations, etc.	02
9	Study stud welding process with the principle of operation, equipment and application.	02
10	Describe laser beam welding process with the principle of operation, equipment and application.	02
11	Demonstrate arc welding operation on Dissimilar metal job which includes plate cutting, marking, weld edge preparation, welding process set-up, tacking, welding operations, etc.	02
12	Demonstrate welding jigs and fixtures.	02
13	Interpret given PQR format for any welding process.	02
14	Interpret given WPS format for any welding process.	02
15	Interpret given WPQ format for any welding process.	02
	Total	**30**

Note :

i. *More **Practical Exercises** can be designed and offered and can be changed 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 & hand tools are compulsory while attending laboratory and has to be brought by students.*

List of Laboratory / Learning Resources Required:

No.	Equipment Name
1	Hand gloves, Welding face guard, Safety goggles, Hand sleeve, Leg guard etc.
2	Welding transformer, Welding rectifier, Welding motor generator,
3	CO_2/MIG/FCAW Welding machine
4	TIG/GTAW Welding machine
5	Welding electrodes/consumables
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, clamp (Tong) tester, Speed glass, Digital weight gauge etc.

Suggested Project List:

1. **Creating Digital Portfolio:** Students should observe and collect photographs and images of industrial/domestic components/items/equipment etc. and make a report on it.
2. **Chart making:** Prepare chart / drawing of different types welding process with its principle, advantages, disadvantages, and applications etc. given by the subject teacher.
3. **Model Making:** Students should build 3D model of various object as per shape and dimension from thermocol, hardboard scrap, wooden scrap, plastic or metal scrap or drawing sheet etc.
   - Prepare a model of different types of welding processes set-up.
   - Prepare a model of different types of welding joint design.
4. **Video Preparation:** Student have to prepare his/her video on demonstrating different types of welding processes, preparation of weld joint design, welding tools-equipment and consumable selection, welding process set-up preparation, any other activities performed in laboratory etc. given by the subject teacher.
5. **E-learning projects:** Students have to use internet and other online resources for preparation of report and/or download video on the topic given by the subject teacher within the syllabus or beyond the syllabus.
6. **Report preparation:** Student has to use different books, technical magazine, journals etc. for preparation of a report on the topic given by the subject teacher within the syllabus or beyond the syllabus.

7. **Power point presentation**: Students has to prepare a power point presentation of 10 to 15 slides on the topic given by the subject teacher within the syllabus or beyond the syllabus. In the end of presentation student has to ask at least 3 to 5 MCQ based question to identify the gain of listeners at the end presentation.
8. **Collect and study brochure** of different types of welding machines, welding tools, equipment, consumables and accessories from local vendor/ online vendor.
9. Draw different joints used for structural fabrication.
10. Prepare special tools/projects/fixtures/models using different welding methods.
11. Prepare a typical programme used for arc welding in Microsoft excel or suitable software.
12. Survey/Visit nearby vendor, prepare sample specifications of GMAW, FCAW, GTAW, PAW, LBM and Stud Welding equipment.
13. Maintenance of available infrastructure related to fabrication i.e., welding equipment, benches, stool, table, doors, grills, solar structure etc.,

Suggested Activities for Students:

1. Prepare solutions of different assignments given by subject faculty.
2. Report writing on various topics from syllabus and beyond syllabus.
3. Prepare sketchbook of Tools and Equipment required for welding.
4. Prepare sketchbook of drawing of various welding process, joint details, welding symbol etc.
5. PPT presentation (10 minutes) on given Sub-topic of subject beyond the syllabus.
6. Prepare a list of specifications for various tools/equipment/machines used in the arc welding.
7. Visit the local metal trader/ fabricator and collect all relevant information regarding welding electrodes, filler wire etc., and prepare detail report on it.
8. Student will visit the respective discipline industry / site and will prepare the list of welding technology related to equipment/machineries used by that industry / site.
9. Show video/animation films of different welding process used in fabrication industries.
10. Collect some industrial weld component, identify type of weld in it & justify welding process used to manufacture that component.
11. Download videos showing correct practices for different types of welding processes.
12. Collect videos, animation showing different welding process used in fabrication industries.
13. Prepare chart showing different types welding process with its principle, advantages, disadvantages, and applications.
14. Prepare chart showing various types of welding defects, causes and its remedies.
15. Arrange visit to fabrication industry to show different types of welding processes used in it.

* * * * *

ANNEXURE-1: SAMPLE SAFETY 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-2 (_____)

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/Instructor.
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.
7. Cut or Tie back long hair, remove jewellery, secure loosed clothing, and wear boiler suit & safety shoes in the laboratory.
8. Clean all work areas and put equipment away before leaving the laboratory.

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

Particulars:

Programme : _____

Batch No. : _____

Enrolment No.: _____

Student Signature

_____