



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Fabrication Technology

Subject Code: DI04055081

Subject Name: Advance Welding Engineering

<b>w. e. f. Academic Year:</b>	2025-26
<b>Semester:</b>	4 <sup>th</sup>
<b>Category of the Course:</b>	Professional Elective - II

<b>Prerequisite:</b>	Basic Welding processes
<b>Rationale:</b>	<p>Welding is a fundamental process in manufacturing, construction, and various industries, serving as the backbone for joining metals and materials. As technology progresses and industries evolve, the demand for advanced welding techniques and expertise continues to grow. The field of welding has witnessed significant technological advancements in recent years, including developments in automation, robotics, and materials science. Advanced Welding Engineering programs can address these emerging technologies and equip students with the skills and knowledge needed to leverage them effectively. Industries such as automotive, aerospace, energy, and construction rely heavily on welding for fabrication and assembly. Employers increasingly seek professionals with expertise in advanced welding techniques to remain competitive in the global marketplace. Offering a specialized program in Advanced Welding Engineering can help meet this demand for skilled professionals.</p>

## Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Describe the advance welding process principle like pulse GTAW, hot wire tig, a tig, ESSC, SASC.	U
02	Describe the principle, working, advantage, disadvantage of solid state welding processes.	U
03	Describe the welding process like Thermit, atomic, under water, narrow gap welding process.	U
04	Describe the radiant energy welding process.	U
05	Describe the weldability test used for checking of weldability.	U

*\*Revised Bloom's Taxonomy (RBT)*



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## Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR		C	Theory		Tutorial / Practical	
			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.	<b>Advance welding processes</b> 1.1 Pulsed GTAW 1.2 High Frequency pulsed GTAW 1.3 Square wave AC GTAW 1.4 Active TIG welding 1.5 Hot wire TIG welding 1.6 Electro Slag Strip Cladding (ESSC) 1.7 Submerged Arc Strip Cladding (SASC) 1.8 Advances in gas metal arc welding - Pulsed GMAW 1.9 Advances in gas metal arc welding - Controlled dip short circuiting processes	8	18
2.	<b>Solid state welding processes</b> 2.1 Cold pressure welding 2.1.1 Definition 2.1.2 Mechanism 2.1.3 Material welded 2.1.4 Base metal surface cleaning 2.1.5 Joint design 2.1.6 Equipment 2.1.7 Application  2.2 Diffusion (bonding) welding 2.2.1 Definition and concept 2.2.2 Methods 2.2.3 Parameters 2.2.4 Materials welded	10	22



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	2.2.5 Advantages 2.2.6 Limitation 2.2.7 Application  2.3 Ultrasonic welding 2.3.1 Definition and concept 2.3.2 Principle of operation 2.3.3 Metallurgy of ultrasonic welds 2.3.4 Equipment 2.3.5 Variables 2.3.6 Types 2.3.7 Materials welded 2.3.8 Advantages 2.3.9 Limitation 2.3.10 Application  2.4 Explosive welding 2.4.1 Definition 2.4.2 Mechanism 2.4.3 Arrangement of explosive welding 2.4.4 Explosive used 2.4.5 Metallurgy of explosive welds 2.4.6 Testing of explosive welds  2.5 Friction welding 2.5.1 Definition 2.5.2 Steps in friction welding 2.5.3 Variables 2.5.4 Materials welded 2.5.5 Joint preparation 2.5.6 Advantages 2.5.7 Disadvantages 2.5.8 Application		
3.	<b>Miscellaneous Advance welding processes</b> 3.1 Thermit welding	8	18



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	3.1.1 Definition 3.1.2 Principle operation 3.1.3 Thermit welding mixtures 3.1.4 Procedure of thermit welding 3.1.5 Advantages, limitation & application  3.2 Atomic Hydrogen Welding 3.2.1 definition 3.2.2 Principle 3.2.3 Operation 3.2.4 Equipment 3.2.5 Advantages 3.2.6 Limitation 3.2.7 Application  3.3 Under water welding 3.3.1 Types 3.3.2 Characteristics of good under water welding 3.3.3 SMAW underwater welding 3.3.4 TIG under water welding 3.3.5 MIG Under water welding 3.3.6 Application of underwater welding  3.4 Narrow Gap Welding Techniques 3.4.1 Principles and features of narrow gap welding 3.4.2 Narrow gap welding processes 3.4.2.1 Narrow gap GTAW 3.4.2.2 Narrow gap GMAW 3.4.2.3 Narrow gap SAW		
4.	<b>Radiant Energy welding processes</b> 4.1 Electron Beam Welding 4.1.1 Introduction 4.1.2 Definition 4.1.3 Principle of operation 4.1.4 Welding atmosphere	7	15



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	<p>4.1.5 Comparison of vacuum and atmospheric welding systems</p> <p>4.1.6 Equipment</p> <p>4.1.7 Variables</p> <p>4.1.8 Safety</p> <p>4.1.9 Advantages</p> <p>4.1.10 Limitation</p> <p>4.1.11 Application</p> <p>4.2 Laser Beam Welding</p> <p>4.2.1 Definition</p> <p>4.2.2 Principle of operation</p> <p>4.2.3 Forms of laser</p> <p>4.2.4 Joint design</p> <p>4.2.5 Advantages</p> <p>4.2.6 Limitation</p> <p>4.2.7 Application</p>		
5.	<p><b>Weldability testing</b></p> <p>5.1 weldability test</p> <p>5.1.1 Theoretical test</p> <p>5.1.2 Simulated test</p> <p>5.1.3 Visual examination</p> <p>5.1.4 Component sampling test</p> <p>5.1.5 Actual welding test</p> <p>5.2 Fabrication weldability test</p> <p>5.2.1 Hot cracking test</p> <p>5.2.1.1 Murex test</p> <p>5.2.1.2 Houldcroft test</p> <p>5.2.1.3 Vareststraint test</p> <p>5.2.1.4 Ring weldability test</p> <p>5.2.1.5 Hot ductility test</p> <p>5.3 Cold cracking test</p> <p>5.3.1 Controlled thermal severity test</p> <p>5.3.2 Tekken test</p> <p>5.3.3 Lehigh restraint test</p> <p>5.3.4 Longitudinal bead weld test</p>	12	27



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5.3.5 Implant test		
5.4 Weldability test related to specific types of cracking		
5.4.1 Lamellar tearing		
5.4.2 Reheat cracking		
5.5 Service weldability test		
5.5.1 Tensile test		
5.5.2 Nick break test		
5.5.3 Pillow test		
5.5.4 Bend test		
5.5.5 Impact test		
5.5.6 Hardness test		
5.5.7 Fracture toughness test		
5.5.8 Fatigue test		
5.5.9 Corrosion test		
5.5.10 Creep test		
<b>Total</b>	<b>45</b>	<b>100</b>

## Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	U Level	A Level	N Level	E Level	C Level
25 %	61%	14%	-	-	-

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

## References/Suggested Learning Resources:

### (a) Books:

S.No.	Title of Books	Author	Publication with place, year and ISBN
1	Welding process	Dr. R. S. Parmar	Khanna Publishers
2	Welding engineering and Technology	Dr. R. S. Parmar	Khanna Publishers
3	Welding technology	O. P. Khanna	Dhanpat rai publications



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S.No.	Title of Books	Author	Publication with place, year and ISBN
4	Advance Welding Processes	John Norrish	Institute of physics publishing Ltd.
5	Friction Stir Welding and processing	Rajiv S. Mishra Murray W. Mahoney	ASM International
6	Modern Arc Welding	S.V.Nadkarni	Oxford Publication
7	Welding Technology and design	V.M.Radhakrishnan	New Age International publication
8	Welding Technology for engineers	Baldev Raj V Shekhar A K Bhaduri	

**(b) Open source software and website:**

1. <https://nptel.ac.in/>
2. <https://www.twi-global.com/technical-knowledge/faqs/faq-how-can-i-assess-the-weldability-of-a-material>
3. <https://www.imtmaelearn.in/>
4. <https://www.wileymetal.com/6-advanced-welding-processes-and-their-applications-explained/>
5. <https://www.millerwelds.com/technologies/advanced-welding-processes>
6. <https://www.thefabricator.com/thefabricator/article/arcwelding/weld-process-advancements>
7. <https://www.youtube.com/watch?v=ghPfvIPWVNQ>

**Suggested Course Practical List:**

Sr. No.	Practical Outcomes (PrOs)	Approx. Hrs. Required
1	Prepare a chart of classification of welding process and prepare a report on their basic requirements i.e, heat source, atmospheric protection, metallurgy, cleaning procedure etc.	4
2	Study the ESSC and SASC process.	2
3	Study ultrasonic welding process.	2



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Sr. No.	Practical Outcomes (PrOs)	Approx. Hrs. Required
4	Study Explosive welding process.	2
5	Study friction welding process.	2
6	Study narrow gap welding process.	2
7	Study Thermit welding process.	2
8	Study Under water welding process.	2
9	Study electron beam welding process.	2
10	Study laser beam welding process.	2
11	Study hot cracking tests and cold cracking tests.	2
12	Perform any one Weldability test of given metallic material.	2
13	Perform tensile test of given welded job.	2
14	Perform side bend test or root bend test or impact test for given job.	2
	<b>TOTAL HOURS.</b>	<b>30</b>

### Note

- 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.
- 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:

Sr. No.	Equipment Name with Broad Specifications
1.	Ultrasonic welding machine
2.	Friction welding set up



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Sr. No.	Equipment Name with Broad Specifications
3.	Friction stir welding machine
4.	ESSC set up
5.	SASC set up
6.	Nozzle for narrow gap welding

## Suggested Project List:

1. Prepare a quiz on advance welding topics
2. Chart making: Prepare the charts on different topic given by faculty.
3. Video Preparation: Student has to prepare his/her video on explaining different topics of subjects given by faculty.
4. 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.
5. 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.
6. 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.

## Suggested Activities for Students:

1. Prepare sketchbook of drawing of various topics of syllabus
2. Prepare a question bank.
3. 10 min PPT presentation on the given topic from the syllabus or beyond the syllabus
4. Report writing on various topics from syllabus and beyond syllabus

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## 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: Advance Welding Engineering (\_\_\_\_\_)

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

\_\_\_\_\_