

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

**COURSE CURRICULUM
COURSE TITLE: ADVANCE WELDING ENGINEERING
(COURSE CODE: 3385509)**

Diploma Programme in which this course is offered	Semester in which offered
Fabrication Technology	8 th Semester

1. RATIONALE

This course provides knowledge and practice of advance welding processes used in fabrication industries. Students develop skills to check weldability and perform different weldability testing for different metals. Students will be able to weld different dissimilar metal and its cladding. Students will get knowledge about application of preheat and PWHT of weld joints as per codes and standards used in fabrication industry. Student will get knowledge about different methods for increasing service life of equipment. Student can develop skill for design and fabrication of welding jigs and fixture.

2. LIST OF COMPETENCY

The course content leading to the achievement of the following competencies:

- **Able to perform different weldability tests for checking weldability of different metals.**
- **Able to learn different surfacing methods and their importance.**
- **Develop jigs and fixtures for welding.**

3. COURSE OUTCOMES

- i. Perform Friction stir welding.
- ii. Demonstrate advance GTAW and narrow gap welding.
- iii. Perform weldability tests.
- iv. Demonstrate cracks in welding.
- v. Perform weld overlay and metal spraying.
- vi. Demonstrate different jig and fixtures used in fabrication shop.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	150
4	-	2	6	70	30	20	30	

Legends:L-Lecture;T-Tutorial/TeacherGuidedStudentActivity;P-Practical;C-Credit;;ESE-EndSemesterExamination;PA- Progressive Assessment.

5. DETAILED COURSE CONTENTS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-Topics
Unit –I ADVANCE WELDING PROCESSES	1a. Understand advance processes development 1b. Understand Advance Welding Processes and its application in fabrication industry 1c. Understand narrow gap	ADVANCE WELDING PROCESSES 1.1 Development trends 1.1.1 Factors affecting need of advance welding processes 1.1.2 Safety environmental factors 1.1.3 Skills and training requirements 1.1.4 Area of development 1.1.5 Process application trends 1.2 Friction Stir Welding process 1.2.1 Introduction FSW 1.2.2 Principle of FSW 1.2.3 Tool shapes and materials 1.3 Advance GTAW process 1.3.1 GTAW process developments 1.3.2 Arc initiation in GTAW 1.3.3 Pulsed GTAW 1.3.4 High frequency pulsed GTAW 1.3.5 Square wave AC GTAW 1.3.6 Hot Wire GTAW 1.4. Narrow Gap Welding 1.4.1 Introduction 1.4.2 Principle and features of narrow gap welding 1.4.3 Narrow gap welding process 1.4.3.1 Narrow gap GTAW 1.4.3.2 Narrow gap GMAW 1.4.3.3 Narrow gap SAW
Unit – II WELDABILITY TESTING	2a. Understand Advance Welding Processes and its application in fabrication industry	WELDABILITY TESTING 2.1. Definition and Concept 2.2. Effect of alloying elements on weldability 2.3. Weldability testing 2.3.1 Classification of weldability testing 2.3.2 Hot cracking test 2.3.2.1 The T joint test 2.3.2.2 The vareststraint Test 2.3.3 Root Cracking Test

		<p>2.3.3.1 The Lehigh Restraint Test</p> <p>2.3.3.2 The circular patch test</p> <p>2.3.4 Cold cracking tests or hydrogen induced cracking tests</p> <p>2.3.4.1 Concept of cold cracking</p> <p>2.3.4.2 Factors affecting Hydrogen induced cracking</p> <p>2.3.4.3 Hydrogen Induced cracking tests</p>
<p>Unit– III</p> <p>CRACKS IN WELDS</p>	<p>3a. Describe different weld cracks</p>	<p>CRACKS IN WELDS</p> <p>3.1. Introduction</p> <p>3.2. Classification of weld cracks</p> <p>3.2.1. Hot cracks</p> <p>3.2.2. Cold cracks</p> <p>3.3 Nomenclature, Location and Orientation of weld cracks</p> <p>3.3.1 Weld metal cracks</p> <p>3.3.2 Base metal cracks</p> <p>3.4 Factors contributing to weld cracking</p> <p>3.5 Specific Weld cracks</p> <p>3.5.1 Chevron cracks</p> <p>3.5.2 Lamellar cracks</p> <p>3.5.3 Reheat cracks</p> <p>3.5.4 Stress Corrosion cracks</p>
<p>Unit– IV</p> <p>DISSIMILAR METAL WELDING AND CLADDING</p>	<p>4a. Describe dissimilar metal and cladding</p>	<p>DISSIMILAR METAL WELDING AND CLADDING</p> <p>4.1. Introduction</p> <p>4.2. Concept of dissimilar metal welding</p> <p>4.3. Metallurgical problems in dissimilar metal welding</p> <p>4.4. Techniques for dissimilar metal welding</p> <p>4.5. Factors influencing joint integrity</p> <p>4.5.1. Weld metal</p> <p>4.5.2. Dilution</p> <p>4.5.3. Melting temperature</p> <p>4.5.4. Thermal conductivity</p> <p>4.5.5. Coefficient of thermal expansion</p> <p>4.6. Welding consideration</p> <p>4.6.1. Welding process</p> <p>4.6.2. Selection of filler metal</p>

		<p>4.6.3. Buttering</p> <p>4.6.4. Joint design</p> <p>4.6.5. Preheat and post weld heat treatments</p> <p>4.7 Service consideration</p> <p>4.7.1 Property consideration</p> <p>4.7.2 Carbon migration</p> <p>4.7.3 Corrosion and oxidation resistance</p> <p>4.8 Weld cladding (overlay)</p> <p>4.8.1 Application considerations</p> <p>4.8.2 Stainless steel to carbon or low alloy steel.</p> <p>4.8.3 Composition control of stainless steel weld overlays</p> <p>4.8.3.1 Control of dilution</p> <p>4.9 Procedures for stainless steel weld cladding (overlay)</p> <p>4.9.1 Submerged arc welding</p> <p>4.9.2 Self shielded flux cored wire</p> <p>4.9.3 Plasma hot wire process</p> <p>4.9.4 Electro slag overlays</p>
<p>Unit- V</p> <p>HARD FACING</p> <p>OF METALS</p>	<p>5a. Describe hard facing of metals</p>	<p>HARD FACING OF METALS</p> <p>5.1 Definition and concept</p> <p>5.2 Objectives of hard facing</p> <p>5.3 Principle of operations</p> <p>5.4 Hard facing alloys</p> <p>5.5 Base metal hard faced</p> <p>5.6 Surfacing methods</p> <p>5.6.1 Oxy acetylene welding</p> <p>5.6.2 SMAW</p> <p>5.6.3 SAW</p> <p>5.6.4 MIG</p> <p>5.6.5 TIG</p> <p>5.6.6 PAW</p>
<p>Unit- VI</p> <p>METAL</p> <p>SPRAYING</p>	<p>6a. Describe different metal spraying methods</p>	<p>METAL SPRAYING</p> <p>6.1 Introduction</p> <p>6.2 Definition</p> <p>6.3 Classification of thermal spraying process</p> <p>6.4 Surface preparations</p> <p>6.5 Flame Spraying</p> <p>6.5.1 Equipment and Description Wire spray Process</p>

		6.5.2 Equipment and Description Powder spray Process 6.6 Advantages of Sprayed Coatings 6.7 Disadvantages of Sprayed Coatings 6.8 Applications of Sprayed Coatings
Unit VII PREHEAT AND PWHT OF WELDMENT	7a. Describe importance of Preheat and PWHT	PREHEAT AND PWHT OF WELDMENT 7.1 Aims of pre heating 7.2 Clip test 7.3 Methods of preheating 7.4 Measurement of preheating temperature 7.5 Preheating temperature of different materials 7.6 Post weld heat treatment 7.7 Preheat and PWHT of some steels
Unit VIII WELDING JIGS AND FIXTURES	8a. Describe welding jigs and fixtures	WELDING JIGS AND FIXTURES 8.1 Introduction 8.2 Welding jigs 8.3 Welding fixtures 8.4 Principle governing design of good welding jigs and fixtures 8.5 Various types of jigs and fixtures

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total
I	Advance welding processes	14	7	7	7	21
II	Weldability testing	9	0	7	0	7
III	Cracks in welds	6	0	7	0	7
IV	Dissimilar metal welding and cladding	9	0	0	7	7
V	Hard facing of metals	5	7	0	0	7
VI	Metal spraying	4	7	0	0	7
VII	Preheat and PWHT of weldment	4	0	0	7	7
VIII	Welding jigs and fixture	5	0	7	0	7
	TOTAL	56	21	28	21	70

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

NOTE:-Suggested specification table shall be treated as a general guidance for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF EXERCISE/PRACTICAL/EXPERIMENTS

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills (**outcomes in psychomotor and affective domain**) so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

*Note: Here only outcomes mainly in psychomotor domain are listed as practical/exercises. However, If these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus overall development of **Programme Outcomes** (as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes

S. No.	Unit No.	Exercise /Practical (Outcomes in psychomotor domain)	Approx. Hrs. Required
1	1	Demonstrate Friction stir welding.	4
2	2	Perform CTS Test to evaluate HIC susceptibility of carbon steel.	4
3	2	Perform T joint Weldability test.(Optional)	4
4	2	Perform Lehigh Restraint test. (Optional)	4
5	2	Perform Longitudinal Bead Weld cracking test. (Optional)	4
6	3	Identify different welding cracks and its causes and remedies.	2
7	4	Perform weld overlay by SMAW process. (SS on CS)	6
8	4	Perform weld overlay by GMAW process. (SS on CS) (Optional)	6
9	4	Perform weld overlay by SAW process. (SS on CS) (Optional)	6
10	5	Perform hard facing on carbon steel using inconel electrode by SMAW process.	4
11	6	Perform metal spraying operation using oxy fuel torch.	2
12	7	Identify effect of preheating on cooling rate and solidification time and mechanical properties of weld joint.	4
13	8	Identify different jigs and fixtures and their use and application in industry.	2
Total Hrs.			28

8. SUGGESTED LIST OF PROPOSED STUDENT ACTIVITIES

Following is the list of proposed student activities:

- 8.1 Prepare sketchbook of drawing of various topics of syllabus
- 8.2 Prepare a question bank.
- 8.3 10 min PPT presentation on the given topic from the syllabus and beyond the syllabus
- 8.4 Report writing on various topics from syllabus and beyond syllabus
- 8.5 Fill up lab manual.

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

- i. Arrange industrial visit.
- ii. Arrange expert lecture.
- iii. Show video films/animation films/photographs of different automated manufacturing process and discuss their features.

10. SUGGESTED LEARNING RESOURCES

A. List of Books

S.No.	Title of Books	Author	Publication
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
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	Narosa Publishing House

B. List of Major Equipment/Instrument

1. SMAW machine and consumables
2. GMAW machine and consumables
3. GTAW machine and consumables
4. SAW machine and consumables
5. Lathe machine tool
6. Hardness testing machine
7. Tensile testing machine
8. Bend test machine
9. Izod Impact test machine.
10. Oxy acetylene welding kit
11. Metal spraying gun with consumables
12. Ultrasonic flaw detector
13. Eddy current testing machine
14. Dye Penetrant kit
15. Different welding jigs and fixtures

C. List of Software/Learning Websites

1. www.nptel.ac.in
2. Welding simulator software

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE**Faculty Members from Polytechnics**

- **Prof. P. B. Pathak**, I/C HOD, Dept of Fabrication Technology, Sir B.P.I., Bhavnagar
- **Prof. B. K. Gandhi**, Sr. Lecturer, Dept of Fabrication Technology, Sir B.P.I., Bhavnagar
- **Prof. S. Y. Merchant**, Sr. Lecturer, Dept of Fabrication Technology, Sir B.P.I., Bhavnagar
- **Prof. N. M. Bhangale**, Lecturer, Dept of Fabrication Technology, Sir B.P.I Bhavnagar

Co-coordinator and Faculty Members from NITTTR Bhopal