

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: WELDING TECHNOLOGY-II
(Code: 3345504)

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

1. RATIONALE

Welding is one of the manufacturing processes which are extensively used in Fabrication Industries. As the pass out student will have to work in the field of Production, Operation and maintenance in Fabrication Industries, it is necessary for the student to learn advance welding techniques and equipment and tools. By undergoing learning experiences under this subject, student will understand the theoretical and practical aspects of welding. Student will be conversant with welding defects, application of relevant standards & codes, operation and maintenance of different Welding Equipment like welding transformers, welding rectifiers etc. Thus it is a very important course for fabrication engineers.

2. COMPETENCY

The course content should be taught and curriculum should be implemented with the aim to develop required skills in the students so that they are able to acquire following competency:

- **“Apply knowledge and skills for a given welding job by using appropriate advanced welding process, equipment, tools, along with optimum process parameters and safe working procedures as per standards and codes.”**

3. COURSE OUTCOMES (COs)

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

- Perform GTAW (Gas Tungsten Arc Welding) / GMAW (Gas Metal Arc Welding), CO₂ welding / FCAW (Flux Core Arc Welding) / PAW (Plasma Arc Welding) on given job.
- Select parameters/variables of welding process for a given job.
- Describe ESW (Electro Slag Welding) / Stud welding / Special welding process.
- Describe different welding defects, its causes and remedies.

4. TEACHING AND EXAMINATION SCHEME

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

Legends: L-Lecture; T – Tutorial/Teacher Guided Student Activity; P - Practical;C – Credit;; ESE - End Semester Examination; PA - Progressive Assessment.

5. DETAILED COURSE CONTENTS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Gas Tungsten Arc Welding (GTAW) or Tungsten Inert Gas(TIG)Welding	1a. Describe GTAW /TIG process parameters. 1b. Explain GTAW /TIG Procedure with applications. 1c. Prepare Job by using GTAW /TIG	1.1 Definition. 1.2 Principle of Operation. 1.3 Welding parameters for different metals. 1.4 Welding Equipment. 1.5 Non Consumable Electrode. 1.6 Filler rod. 1.7 Inert Gases. 1.8 Different metals welded. 1.9 Joint Design. 1.10 Advantages, Disadvantages & Applications.
Unit– II Gas Metal Arc Welding(GMAW) orMetal Inert Gas (MIG) Welding	2a. Describe GMAW / MIG process parameters. 2b. Explain GMAW / MIG Procedure with applications. 2c. Prepare Job for GMAW/ MIG in a given situation.	2.1 Definition. 2.2 Principle of operation. 2.3 Welding set up. Welding Parameters for different materials. 2.4 Welding Equipment. 2.5 Welding Torch. 2.6 Wire feed mechanism. 2.7 Different Shielding Gases used. 2.8 Different metals welded. 2.9 Joint Design. 2.10 Advantages, Disadvantages & Applications.
Unit– III CO₂ Welding or Metal Active Gas (MAG) Welding	3a. Describe CO ₂ / (MAG) welding process parameters. 3b. Explain CO ₂ / (MAG) Welding Procedure and its field applications. 3c. Describe Applications of CO ₂ / (MAG) Welding	3.1 Definition. 3.2 Principle of Operation. 3.3 Welding Equipment. 3.4 Welding Variables and Parameters. 3.5 Joint Design. 3.6 Welding Procedure. 3.7 Advantages, Disadvantages & Applications.
Unit– IV Flux Cored Arc Welding (FCAW)	4a. Describe FCAW process parameters. 4b. Describe FCAW Procedure. 4c. Prepare the given Job by using FCAW 4d. Describe Applications of FCAW	4.1 Definition and concept. 4.2 Principle of Operation. 4.3 Welding Equipment. 4.4 Different metals welded. 4.5 Joint Design. 4.6 Welding Parameters. 4.7 Flux cored electrode wire and its functions. 4.8 Advantage, Limitation & Application.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit– V Electro Slag Welding (ESW)	5a. Explain working principle, operation and of process parameters of ESW. 5b. Describe ESW Procedure, equipment and applications	5.1 Definition and Concept. 5.2 Principle of Operation. 5.3 Conventional Electro Slag Welding 5.4 Consumable Guide Electro Slag Welding. 5.5 Welding Equipment 5.5.1 Power Source 5.5.2 Welding Head 5.6 Electrode Wire 5.7 Fluxes and its Properties. 5.8 Joint Preparation. 5.9 Welding Parameters for different Plate Thicknesses 5.10 Advantages, Disadvantages & Applications.
Unit– VI Plasma Arc Welding (PAW)	6a. Describe process parameters, procedure and equipment of PAW. 6b. Distinguish between PAW and TIG Welding. 6c. Describe Applications of PAW and its advantages.	6.1 Definition and Concept. 6.2 Principle of Operation. 6.2.1 Non-transferred Arc Process 6.2.2 Transferred Arc Process 6.3 Equipment 6.3.1 Power Source 6.3.2 Plasma Torch 6.4 Shielding Gases 6.5 PAW Fixture. 6.6 Type of Joints. 6.7 Welding Parameters for Different Metals. 6.8 Base Metals Welded 6.9 Joint Design 6.10 Backing Requirement. 6.11 Comparison between PAW and TIG Welding. 6.12 Advantages, Disadvantages & Applications.
Unit– VII Stud Welding	7a. Describe Stud Welding process. 7b. Describe Stud Welding Procedure. 7c. Describe Applications of Stud Welding.	7.1 Definition and Concept. 7.2 Principle of Operation. 7.3 Classification - Non Conductor Ferrule Method - Semi Conductor cartridge Method 7.4 Equipment 7.5 Base Metals Welded 7.6 Advantages, Limitation & Applications.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit– VIII Special Welding Processes	8a. Explain principle of operation, welding variables and 7 disadvantages of various Special Welding processes. 8b. Set and Operate Special Welding Process equipment. 8c. Describe Applications & Limitations of Special Welding Processes.	8.1 ULTRASONIC WELDING 8.1.1 Definition and Concept. 8.1.2 Principle of Operation. 8.1.3 Equipment. 8.1.4 Welding Variables. 8.1.5 Types of Weld 8.1.6 Base Metals Welded. 8.1.7 Advantages, Disadvantages & Applications. 8.2 EXPLOSIVE WELDING 8.2.1 Definition and Concept. 8.2.2 Mechanism (Principle of Operation) 8.2.3 Arrangements.(Set-up) 8.2.4 Explosive Material Used. 8.2.5 Advantages, Limitation & Applications. 8.3 ATOMIC HYDROGEN WELDING 8.3.1 Definition. 8.3.2 Principle & Operation. 8.3.3 Welding Parameters for different Plate Thicknesses. 8.3.4 Equipment 8.3.5 Advantages, Disadvantages & Applications. 8.4 ELECTRON BEAM WELDING 8.4.1 Definition. 8.4.2 Sequence of Operation. 8.4.3 Different atmospheric conditions for Welding. 8.4.4 Equipment. 8.4.5 Process variables 8.4.6 Safety aspects 8.4.7 Advantages, Disadvantages & Applications. 8.5 LASER BEAM WELDING 8.5.1 Definition & Concept. 8.5.2 Principle & Theory of Operation. 8.5.3 Forms of Laser. 8.5.4 Types of Joint. 8.5.5 Advantages, Disadvantages & Applications. 8.5.6 Safety Aspect. 8.6 UNDER WATER WELDING 8.6.1 Concept.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
		8.6.2 Problems. 8.6.3 Types. 8.6.4 Cavity Welding. 8.6.5 Characteristics of Good Underwater Welding. 8.6.6 List of Different Welding methods Used. 8.6.7 Applications.
Unit- IX Welding Defects & Distortion	9a. List Welding Defects & types of Distortion. 9b. Describe Causes & Remedies for welding Defects & Distortion.	9.1 List, Causes and remedies of Common weld Defects. 9.2 Concept of Distortion in Welds. 9.3 Types of Distortion.
Unit- X A.S.M.E. Sec IX For Welding	10a. Interpret ASME Sec-IX codes applicable for welding. 10b. Describe WPS, PQR, WPQ Format.	10.1 Concept & Scope 10.2 Content of ASME Sec-IX 10.3 Reading of format of Welding Procedure Specification (WPS) 10.4 Reading of format of Welder's Skill Performance Qualification (WPQ) 10.5 Reading of format of Procedure Qualification Record (PQR)

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	Gas Tungsten Arc Welding (GTAW) or Tungsten Inert Gas(TIG) Welding	8	0	5	5	10
II	Gas Metal Arc Welding (gmaw) or metal inert gas (MIG) welding	8	0	5	5	10
III	CO ₂ Welding or Metal Active Gas (MAG) Welding	4	0	2	3	5
IV	Flux Cored Arc Welding (FCAW)	4	0	2	3	5
V	Electro Slag Welding (ESW)	4	0	2	3	5
VI	Plasma Arc Welding (PAW)	4	0	2	3	5
VII	Stud welding	4	0	2	3	5
VIII	Special welding processes	12	4	6	4	14
IX	Welding defects, distortion & its control	4	0	3	3	6
X	A.S.M.E. Sec. IX for welding	4	5	0	0	5
Total Hrs		56	09	29	32	70

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

Note: This specification table shall be treated as a general guideline 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

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 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 over all 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 (Outcomes' in Psychomotor Domain)	Approx Hrs. Required
1	I to VIII	Prepare list of tools and equipments used in Welding Laboratory	02
2	I to VIII	Perform welding operation using speed glass welding screen	02
3	I to VIII	Perform Stainless steel welding job using GTAW process	02
4	I	Perform Aluminium welding job using GTAW process	02
5	I	Perform Copper welding job using GTAW process	02
6	II	Perform Mild steel welding jobs using GMAW process (Two jobs of different types)	04
7	IV	Perform Mild steel welding job using FCAW	02
8	I to IV	Perform Arc welding operation for dissimilar metal process (Two jobs of different metal combinations)	04
9	I to VIII	Measure OCV, CCV and ampere using Clamp (TONG) tester	02
10	X	Interpret given WPS Format for GTAW process	02
11	X	Interpret given PQR Format for GTAW process	02
12	X	Interpret given WPQ Format for GTAW process	02
Total Hrs			28

8. SUGGESTED LIST OF PROPOSED STUDENT ACTIVITIES

Following is the list of proposed student activities:

- i. Prepare sketchbook of drawing of various Welding process, joint details, welding symbol etc
- ii. Preprepare PPT presentation from the topic of syllabus and beyond the syllabus
- iii. Report writing on various topics from syllabus and beyond syllabus

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

- i. Show video/animation films explaining process of different type of welding operations. Also discuss the welding defects, precautions to avoid them and remedial measures. (NITTTTR Bhopal has also developed series of video films with Welding Research Institute Trichi on different welding operations)
- ii. Arrange a visit to a fabrication industry and show different welding operations being carried out.

10. SUGGESTED LEARNING RESOURCES**A. List of Books**

S. No.	Title of Books	Author	Publication
1	Welding Technology	O.P.Khanna	Dhanpatrai publication
2	Welding Engineering & Technology	R.S.Parmar	Khanna Publishers
3	Welding Processes & Technology	Dr. R.S.Parmar	Khanna Publishers
4	Modern Arc welding Technology	S.V.Nadkarni	Oxford & IBH Publishing co.
5	Welding Technology for Engineers	Baldev raj	Narosha Publishing House
6	Welding Technology & Design	V.M. Radhakrishnan	New age international publisher.
7	ASME Code Sec-IX	ASME	ASME
8	Training Material for welding Technology	-----	L&T
9	Steel Structure Fabrication & Erection	Saxena & Asthana	Somaiya publisher

B. List of Major Equipment/ Instrument

- i. GTAW Equipment
- ii. GMAW Equipment
- iii. CO₂ Welding Equipment
- iv. FCAW Equipment
- v. TIG cum PAW Equipment
- vi. Welding Jigs & Fixtures.
- vii. Welding Electrodes/Consumables.
- viii. Personal Protective Equipment.
- ix. Raw Materials for Jobs.

C. List of Software/Learning Websites

- i. www.lincolnelectric.com
- ii. www.esab.com
- iii. www.psweld.com
- iv. www.aws.org
- v. www.froneous.com
- vi. www.iiwindia.com
- vii. www.asme.org
- viii. www.kusakabekikai.co.jp

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

- **Prof. P. B. Pathak**, Convener & 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

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. A. K. Sarathe**, Associate Professor Department of Mechanical Engineering.
- **Prof Sharad Pradhan**, Head and Associate Professor Department of Mechanical Engineering