

## GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

### Course Curriculum

#### JOINING OF METALS (Code: 3332101)

Diploma Programmes in which this course is offered	Semester in which offered
Metallurgy Engineering	3 <sup>rd</sup> Semester

### 1. RATIONALE

Diploma Metallurgy Engineers are expected not only to supervise the joining operation carried out in manufacturing workshops, but also take initiatives in selecting suitable process and materials as per the specific needs of different metals and alloys. Since joining of metals is an important manufacturing route to fabricate bulk storage and processing equipments. The subject focuses on knowledge and understanding of various joining process and equipments, the underlying principles and their relative merits and demerits. Basic understanding regarding weldability of different metals and alloys is also duly emphasised. Thus it is a key course, mastery of which is important for students of metallurgy.

### 2. COMPETENCY (Programme Outcome according to NBA Terminology)

The course content should be taught and with the aim to develop different types of skills so that students are able to acquire following competency:

- **Join metals using various welding processes.**

### 3. 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	200
4	0	4	8	70	30	40	60	

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

#### 4. COURSE DETAILS

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
<b>Unit – I Metal Joining Processes</b>	1a. Describe purposes and importance of joining processes. 1b. Classify metal joining process. 1c. Describe Safety aspects in welding 1d. Describe the features of various types of joints 1e. Select the relevant joining process for the given application	1.1 Joining process as a manufacturing route. 1.2 Relevance of joining process to metallurgy. 1.3 Different types of joining process. 1.4 Classification of joining process. 1.5 Safety aspects in Metal joining processes. 1.6 Types of joints used in welding.
<b>Unit – II Soldering And Brazing</b>	2a. Differentiate between soldering and brazing. 2b. Describe core concept of Metallurgical factors affecting Soldering and Brazing. 2c. Choose between brazing and soldering for the given application, with justification	2.1 Basic operational steps of Soldering. 2.2 Basic operational steps of Brazing. 2.3 Flux and its role in joining process. 2.4 Different types of fluxes. 2.5 Metallurgical aspects of soldering and brazing. 2.6 Applications of soldering and brazing. 2.7 Soldering and Brazing Alloys.
<b>Unit – III Fusion Welding Process</b>	3a. Classify different welding process. 3b. State the features of characteristics of different welding process. 3c. Distinguish between electric arc welding and gas welding 3d. Differentiate Arc welding and Gas welding process. 3e. Describe advantages and Limitation of various welding processes. 3f. Select the material to be welded by gas welding for the given application	3.1 Classification of welding process. 3.2 Gas welding. 3.3 Arc welding process (equipments, fluxes, electrodes, procedures, limitations and advantages of various arc welding process). 3.4 Relative advantages and limitations and applications of gas welding and arc welding 3.5 Thermit welding.
<b>Unit – IV Pressure Welding</b>	4a. Describe joining pressure processes. 4b. Describe the welding methods for miniature/point contacts. 4c. State the advantages, limitations and applications of pressure welding processes. 3g. Select the material to be welded by pressure welding for the given application	4.1 Resistance welding. 4.2 Cold welding. 4.3 Forge welding. 4.4 Relative advantages, limitation and applications of pressure welding. 4.5 Spot welding, explosion welding, Flash welding
<b>Unit – V Modern Welding Processes</b>	5a. Describe modern joining processes and their applications. 5b. State the advantages, limitations and applications of modern welding processes. 3h. Select the relevant modern joining process for good quality joints for the	5.1 Electron beam welding. 5.2 Laser beam welding. 5.3 Submerged arc welding. 5.4 Ultrasonic welding. 5.5 Under water welding.

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
	given application.	
<b>Unit – VI Quality Control In Metal Joining Process</b>	6a. Describe the defects occurring during welding. 6b. List the remedies for prevention of defects. 6c. List the various tests to evaluate welded joint. 6d. State the destructive tests to evaluate welded joint. 6e. Describe various metallurgical aspects for joining different materials 6f. Assess the cost of welding for the given application.	6.1 Weldability of different metals and alloys. 6.2 Welding defects and prevention. 6.3 Inspection and testing of welded joints. 6.4 Special procedures adopted for Stainless Steel, Aluminum, Copper, Cast Iron and Cast Steel 6.5 Welding standards/ codes / specification 6.6 Cost effectiveness in welding

## 5. SUGGESTED SPECIFICATION TABLE WITH HOURS and MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
1.	Introduction	4	1	2	3	06
2.	Soldering And Brazing	6	2	4	4	10
3.	Fusion Welding Process	10	4	4	4	12
4.	Pressure Welding	12	3	5	6	14
5.	Modern Welding Processes	12	3	5	6	14
6.	Quality Control In Metal Joining Process	12	3	5	6	14
<b>Total</b>		<b>56</b>	<b>16</b>	<b>25</b>	<b>29</b>	<b>70</b>

**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.

## 6. SUGGESTED LIST OF EXERCISES/PRACTICALS

The practical/exercises should be properly designed and implemented with an attempt to develop different types of practical skills (**Course 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 Course Outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of **Programme Outcomes/Course Outcomes in affective domain** as given in a common list at the beginning of curriculum document for this programme. Faculty should refer to that common list and should ensure that students also acquire those Programme Outcomes/Course Outcomes related to affective domain.

S. No.	Unit No.	Practical/Exercise (Course Outcomes in Psychomotor Domain according to NBA Terminology)	Apprx. Hrs. Required
1	I	Identify various safety gadgets used in welding process.	04
2	II	Perform soldering operation.	04
3	III	Identify various parts of arc welding machine.	04
4	III	Perform arc welding process (4 different jobs).	08
5	III	Identify various parts of gas welding machine.	04
6	III	Perform gas welding process (4 different jobs).	08
7	IV	Identify various parts of spot welding machine.	04
8	IV	Perform spot welding process.	04
9	V	Identify the parts of the Laser beam welding, Submerged arc welding, Electron beam welding.	04
10	VI	Identify various welding defects.	04
11	VI	Perform DT and NDT for weld joints like Tensile testing, Ultrasonic testing, Visual inspection	04
<b>Total</b>			<b>56</b>

## 7. SUGGESTED LIST OF STUDENT ACTIVITIES

- i. Visit industries, organisations, where differ kinds of welding are being done. Observe, study and prepare report.
- ii. Carryout hands on practice of manual metal arc welding process in workshop and other places.
- iii. Perform non-destructive tests to evaluate welded joint.
- iv. Present case studies.
- v. Group discussion on selection of welding process for different jobs.

## 8. SPECIAL INSTRUCTIONAL STRATEGIES (If Any)

- i. Give hands on practice for welding and testing.
- ii. Visit to the Industry.
- iii. Show videos of modern welding process.

## 9. SUGGESTED LEARNING RESOURCES

### A) List of Books

S. No.	Title of Books	Author	Publication
1	Engineering metallurgy I and II	R.A.Higgins	The English University Press Ltd.
2	Welding technology	O.P.Khanna	DhanpatRai Publications Ltd. New Delhi,
3	Soldering, welding and brazing	Lankester	George Allen and Unwin, London.
4	Modern arc welding techniques	S.V. Nadkarni	Oxford IBH Publishers.
5	Welding technology	R.S.Parmar	Khanna Publishers, NewDelhi
6	Welding engineering	Richard little	Tata McGraw Hill, NewDelhi

**B) List of Major Equipment/Materials with Broad Specification**

- i. Electric Arc welding machine and safety gadgets.
- ii. Gas welding machine.
- iii. Universal testing Machine
- iv. Ultrasonic tester ( NDT )
- v. Dye-Penetrant test kit.

**C) List of Software/Learning Websites**

- i. <http://www.iws.org.in/>
- ii. <http://www.asme.org>
- iii. <http://www.aws.org>
- iv. <http://www.ewf.be>
- v. <http://www.astm.org>

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

- **Prof. S.L. Chauhan**, I/c HOD, Government Polytechnic, Bhuj
- **Dr. I. B. Dave**, Head, Department of Metallurgy Engineering, Dr. S and S S Gandhi Engg. College, Surat.

**Coordinator and Faculty Members from NITTTR Bhopal**

- **Dr. C. K. Chugh**, Professor, Department of Mechanical Engineering
- **Prof. Sharad Pradhan**, Associate Professor, Department of Mechanical Engineering