GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

Course Curriculum

WELDING TECHNOLOGY-I

(Code: 3335504)

Diploma Programme in which this course is offered	Semester in which offered
Fabrication Technology	**3rd 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 Welding Technology. By undergoing learning experiences under this subject, student will know the theory and practice of Welding. Student will be conversant with operation and maintenance of different Welding Equipments like Welding transformers, Welding Rectifiers etc. This is a key course for fabrication engineers.

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

The course content is leading to the achievement of the following competency:

- **Perform SMAW, SAW and ESW type welding operations for making fabrication jobs**

3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**ESE**	**PA**	**ESE**	**PA**	**150**
4	0	2	6	70	30	20	30	

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 as per NBA terminology)	Topics and Sub-topics
Unit – I **Introduction to welding**	1a. Describe meaning and classification of welding as fabrication process. 1b. Describe scope and application of arc welding in fabrication industries. 1c. Describe different types of weld joints 1d. Differentiate welding compared to other processes.	1.1 Need, Scope & importance of welding in industries. 1.2 List of major Fabrication industries in GUJARAT. 1.3 Definition of welding. 1.4 Classification of welding & allied process. 1.5 Advantages & Disadvantages of welding 1.6 Welding as compare to riveting & casting 1.7 Criteria for welding process selection 1.8 Weld joints.
Unit – II **Arc Welding (SMAW, SAW, ESW) Equipment**	2a. Describe different types of Arc welding equipment. 2b. Select particular welding equipment for given welding. 2c. Describe Specifications of different welding equipment.	2.1 Arc welding Equipment. 2.2 Selection factor for power source. 2.3 Arc welding power source with constructional Figure, Typical specification of OCV, CCV, Duty cycle, Current rating and insulation class, advantages, disadvantages. -DC generator set -AC-DC rectifier -Thyristor controlled rectifier -Inverter systems -AC generators -AC transformers 2.4 Weld bead cleaning Accessories
Unit – III **Welding Consumable for SMAW, SAW**	3a. Describe different types of welding consumables. 3b. Describe classification and select particular types welding consumable for given welding application. 3c. Describe method for care and storage of welding consumables.	3.1 Definition of welding electrode. 3.2 Classification chart of welding electrode. 3.3 Electrode shapes, polarity and its effects. -AC -DCRP -DCSP 3.4 Coding Method (Specification) of consumable electrode. 3.5 Electrode coating ingredients and their functions. 3.6 Selection criteria of electrodes. 3.7 Care and storage of electrodes.

Unit	Major Learning Outcomes (Course Outcomes as per NBA terminology)	Topics and Sub-topics
Unit – IV **Weld joints, Welding symbols, Welding Position and Joint Design principles**	4a. Describe different type of weld joints and their symbols. 4b. Describe different welding positions. 4c. Explain basic principles of weld joint design.	4.1 Five basic types of weld joints 4.2 Nomenclature of Fillet weld and Groove weld 4.3 Weld bead geometry -Introduction -Types -Factors affecting -Welding run -Effect of current/voltage 4.4 Standard welding position for butt welds in plates & pipes. 4.5 Standard welding position for fillet welds in plates & pipes. 4.6 Standard location of elements of a welding symbol 4.7 Basic principles of weld joint design
Unit – V **Welding Arc Physics**	5a. Explain theory of Welding arc physics. 5b. Describe importance of stable arc for quality welding.	5.1 Introduction 5.2 Welding arc -Definition -Initiation -Structure -Mechanism 5.3 Arc Characteristics -Volt-amp charactristics -Volt-arc length charactristics 5.4 Arc stability 5.5 Arc blow -Definition -Factors affecting -Types -Mechanism -Effects and remidies 5.6 Metal transfer theory

Unit	Major Learning Outcomes (Course Outcomes as per NBA terminology)	Topics and Sub-topics
Unit – VI **Shielded Metal Arc Welding (SMAW/ MMAW) process**	6a. Describe SMAW/MMAW as mostly used welding process. 6b. Describe applications of SMAW/MMAW	6.1 Definition 6.2 Principle of processes 6.3 SMAW welding with figure & description. 6.4 Typical edge preparation for Butt-Joint. 6.5 Electrode weaving motion patterns. 6.6 Advantages & Limitations. 6.7 Application.
Unit – VII **Submerged Arc Welding (SAW) process**	7a.Describe SAW as Quality welding process in heavy fabrication. 7b. Explain different variables of SAW 7c.Describe application of SAW	7.1 Definition 7.2 Principle 7.3 SAW operation with figure 7.4 SAW equipment 7.5 Weld Backing 7.6 Variants -Double electrode single power source. -Double electrode multiple power source - Triple electrode multiple power source. 7.7 Advantages & Disadvantages 7.8 Application 7.9 SAW consumable
Unit – VIII **Introduction to Welding code ASME sec-IX**	8a. Describe different codes & standards applicable to Fabrication industries. 8b. Describe meaning of ASME sec IX WPS, WPQ and PQR.	8.1 Meaning & objective of codes & standards. 8.2 Different codes & Standard related to fabrication industries. 8.2.1 Meaning & objective of ASME 8.2.2 List of different division & section of ASME 8.2.3 Scope of ASME sec-IX in Fabrication Industries. 8.2.4 Meaning of WPS, WPQ, PQR as Per ASME sec-IX. 8.2.5 Meaning of P No., F No., A No,. as per ASME sec-IX.

Unit	Major Learning Outcomes (Course Outcomes as per NBA terminology)	Topics and Sub-topics
Unit – IX **Weld Quality**	9a. Explain meaning of weld Quality. 9b. Describe different types of weld defects its causes & remedies.	9.1 Weld Quality - Meaning - Five factors to be considered. 9.2 Defects in weld - Types with figure - Causes - Remedies.

5 SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (Theory)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
1	Introduction to Welding	4	4	2	0	6
2	Arc Welding (SMAW, SAW) Equipment	8	2	4	4	10
3	Welding Consumable for SMAW, SAW	6	3	2	2	7
4	Weld joints, Welding symbols, Welding Position and Joint Design principles	8	4	4	2	10
5	Welding Arc Physics	8	2	6	2	10
6	Shielded Metal Arc Welding (SMAW/MMAW) process	6	2	2	3	7
7	Submerged Arc Welding (SAW) Process	6	3	2	2	7
8	Introduction to Welding code ASME sec-IX	6	2	3	2	7
9	Weld Quality	4	2	0	4	6
	Total	**56**	**24**	**25**	**21**	**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.

6 SUGGESTED LIST OF EXERCISES/PRACTICAL

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)	Approximate Hrs. Required
1	I	Prepare a layout of Arc Welding workshop	1
2	II	Identify different Arc Welding Equipments with their Specification.	2
3	I, II	Demonstrate use of safety equipment and protective clothing to be used in Arc Welding.	1
4	I, II	Demonstrate general Safety rules to be observed in arc welding shop.	1
5	III, IV,V,VI	Practice Down head (FLAT) Position welding (1G) by SMAW process on Job No.1	4
6	III, IV,V,VI	Practice HORIZONTAL Position welding (2G) by SMAW process on Job No.1	2
7	III, IV,V,VI	Practice VERTICAL Position welding(3G) by SMAW process on Job No.2	4
8	III, IV,V,VI	Practice OVERHEAD Position welding (4G) by SMAW process on Job No.2	2
9	III, IV,V,VI	Prepare a Job using Circular Seam Welding position (5G) by SMAW process.	4
10	VII	Demonstrate SAW process.	2
11	VIII	Prepare WPS format for given job welding	1
12	VIII	Prepare WPQ format for welder qualification	1
13	VIII	Prepare PQR format for procedure quality for SAW process.	1
14	IX	Identify different welding defects, its causes & remedies.	2
		Total	**28**

7 SUGGESTED LIST OF STUDENT ACTIVITIES

a. Quiz on welding topics
b. Welding quality competition
c. Power point presentation by students on given topic.
d. Visit to Fabrication shops/industries to observe SMAW, SAW and ESW welding and prepare reports.

8. SPECIAL INSTRUCTIONAL STRETAGIES (If Any)

Students should be shown video/animation films to explain the process of welding and specially to explain that what happens at the point of joint during welding process since it is not possible to see this directly through naked eyes.

9. SUGGESTED LEARNING RESOURCES

(A) List of Books:

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

B. List of Major Equipment/Materials

a. Welding Transformer - Single phase
b. Welding Transformer - Three phase
c. Welding Rectifier - Three phase
d. DC Welding Generator.
e. Submerged Arc Welding Equipment.
f. Inverter based Portable Welding Equipment.
g. Welding Electrodes/Consumables.
h. Safety Clothing's & Equipments.
i. Raw Materials for Jobs.

C List of Software/Learning Websites

a. http://www.lincolnelectric.com/en-us/education-center/welding-safety/Pages/welding-safety.aspx
b. http://en.wikipedia.org/wiki/Submerged_arc_welding
c. http://www.ewf.be/media/documentosDocs/doc_82_mmaw_tecnical_bulletin.pdf
d. http://www.esab.com/global/en/
e. http://eagar.mit.edu/EagarPapers/Eagar109.pdf
f. http://www.jflf.org/pdfs/papers/quality.pdf
g. www.aws.org/educators/Library/0000/000060.ppt
h. http://www.ddu.ac.in/academics/fot/mech/wp-content/uploads/2012/07/Chapter-3B_MDID.pdf
i. http://www.tech.plym.ac.uk/sme/strc201/wdefects.htm
j. http://mercury.kau.ac.kr/welding/Welding%20Technology%20II%20-%20Welding%20Metallurgy/Chapter%209%20-%20Welding%20Defects.pdf

10. 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

Co-coordinator and Faculty Members from NITTTR Bhopal

- **Dr. A.K. SARATHE,** Associate Professor Deptt. of Mechanical Engineering
- **Dr. C.K.CHUGH**, Professor, Department of Mechanical Engineering