GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3172116
Semester – VII
Subject Name: Welding Metallurgy

Type of course: Engineering/science

Prerequisite: Basics Materials Processing, Physical Metallurgy & Phase transformations

Rationale:
The Welding Metallurgy course focuses on Basics of Welding Metallurgy and Weld ability issues with Ferrous and Non- Ferrous metals and alloys-their welding defects , appropriate remedies and weld ability Tests. This course helps the welding practice engineer gain the knowledge to successfully join different materials by understanding the problem of weldability issues and applying the knowledge to solve the issues.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	1	0	4	70	30	00	00	100

Content:

Sr. No.	Content	Total Hrs
1	Thermal Cycles Heat flow - temperature distribution-cooling rates - influence of heat input, joint geometry, plate thickness, preheating.	05
2	Solidification Epitaxial growth - weld metal solidification - columnar structures and growth morphology- effect of welding parameters - absorption of gases - gas/metal and slag/metal reactions.	05
3	Welding Metallurgy of Ferrous Materials Phase transformations- weld CCT diagrams - carbon equivalent-preheating and post heating- welding of carbon steel, low alloy steels, cast irons– Processes, difficulties, microstructures, defects and remedial measures.	08
4	Welding Metallurgy of Stainless Steels (Austenitic, Ferritic, Martensitic, Duplex and PH stainless steels), use of Schaeffler, Delong, WRC-1992 diagrams, difficulties, microstructures, defects and remedial measures.	08
5	Welding Metallurgy of Non Ferrous Materials: Welding of Copper, Aluminum, Titanium , Nickel and their alloys – Processes, difficulties, microstructures, defects and remedial measures.	08
6	Weld Defects and Weldability Tests : Origin - types - process induced defects, - significance - remedial measures, Hot cracking - cold cracking -lamellar tearing - reheat cracking, Varestraint test for weldability.	08

	Total	**42**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10%	**20%**	**35%**	**30%**	**05%**	**0%**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's 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.

Reference Books:

1. Welding Processes and Technology, By R. S. Parmar · 2001, Khanna Publishers, ISBN:9788174091260, 8174091262
2. Introduction to the Physical Metallurgy of Welding, By Kenneth Easterling · 2013, ISBN:9781483141664, 1483141667
3. Welding Metallurgy By Sindo Kou, Wiley Publication, 2003, ISBN:9780471460930, 0471460931
4. Welding Metallurgy And Weldability Of Stainless Steels By John C. Lippold, Wiley Publication, Damian J. Kotecki , 2011, ISBN:9788126529476, 8126529474
5. Welding Metallurgy and Weldability of Nickel-Base Alloys, Wiley Publication, By John C. Lippold, Samuel D. Kiser, John N. DuPont · 2011
6. AWS Handbook Volume I, 2019

Course Outcomes

Sr. No.	CO statement	Marks % weightage
CO-1	Understand the basics of welding metallurgy	50
CO-2	Applying the Welding metallurgical knowledge to solve the weldability issues.	35
CO-3	Analyze the weld defects, suggest proper remedies and correct welding practices.	15

List of Tutorials:

1. Numerical based on heat transfer during fusion welding process.

2. Effect of welding parameters on microstructure and weld bead morphology.
3. Importance of carbon equivalent for welding of CS/LAS.
4. Application of Schaeffler/Delong/WRC-1992 Diagram.
5. Precautions and care required during welding of Non-ferrous alloys.
6. Identification of weld defects-causes and remedial measures.
7. Importance of weldability and Varestraint Test for measuring weldability.
8. Report on Industrial Visit / Expert Talk. / Training / Seminar.

List of Open Source Software/learning website:

1. https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-mm19/
2. https://freevideolectures.com/course/4083/nptel-welding-metallurgy
3. https://www.youtube.com/watch?v=W7Ak5m9UX3c
4. https://www.youtube.com/watch?v=fDw5B55rGug