

GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: METALLURGY

SUBJECT NAME: Advances in Welding Metallurgy

SUBJECT CODE: 2172111

B.E. 7th SEMESTER

Type of course: Science & Engineering

Prerequisite: Knowledge of metal joining Processes.

Rationale: The course on Advance Welding Technology covers the broad spectrum on various State of the art welding technologies. The need for understanding advance technology necessitates by the fact that technology is continuously changing. New candidate materials for metal fabrication demands for improved performance in service life. But also demands specialized welding technologies in order to achieve the high quality in terms of Microstructure, Mechanical & Corrosion performance.

Looking at this scenario, the present course covers the information related to latest Welding power source technologies to enable to produce desired microstructure & properties of the joints supported by latest development In Welding electrodes & formulated Gas mixtures. Various solid state welding process like FW, FSW replace conventional joining techniques for Light metals & their alloys like Aluminum, copper & Titanium & the need for automation-Robotic welding for automobile industries.

The present course will best bridge up the gap between the demand of the industry & the academic curricula.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
				ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
4	0	2	6	70	30	0	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Development of Welding Processes, Energy Intensity of Welding Processes, Areas for recent development.	4	7
2	Welding power source technology: Practical implications of electronic power regulation and control-Thyristor control, Synergic pulse process, and Inverter control Power with high functions/performances, Introduction of Fuzzy control, Intelligent Systems.	8	13
3	Advances in Consumables:- MMAW consumables, Submerged arc welding consumables, Filler wires for GMAW and FCAW, deposition rate efficiency, applications for specific metals & alloys. Shielding gases for Arc welding processes, Shielding gas options, Shielding gas mixtures for specific applications, Gases for GTA welding of steels, Gases for plasma welding, Gases for laser welding.	8	13
4	Advances in Solid state welding processes: Friction Welding, Friction Stir Welding and Processing: Principle, tools, process Variables, merits, demerits & applications. Friction Stir Channeling, Friction Stir surfacing, Friction Stir Welding and Processing equipment / machine:	10	18

	Use of Vertical milling machine for Friction Stir Welding and Processing, Friction Stir Channeling, Friction Stir surfacing etc.		
5	Advanced Gas tungsten arc welding, Process developments, Process variants, Square wave AC, variable polarity GTAW, Hot-wire GTAW, Dual-gas GTAW, High efficiency twin-arc, Buried arc GTAW, Multicathode GTAW.	8	13
6	Gas metal arc welding , process developments- Controlled Arc transfer techniques, Extended operation and high deposition welding, tandem MIG Operation.	6	10
7	High-energy density processes, Plasma keyhole welding, Laser welding, Electron beam welding, Laser-enhanced GTAW and GTAW augmented laser welding, Narrow-gap welding techniques, plasma welding :- Features and applications.	8	13
8	Welding automation and robotics, need for automation, robotic basics, coordinate systems, Robot control systems applications, welding simulations	8	13
	Total	60	100

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	30	35	10	10	05

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. ADVANCED WELDING PROCESSES -Technologies and process control John Norrish Woodhead Publishing in Materials. S V Nadkarni,
2. Modern Arc Welding Technology, Ador Welding Limited, 2010, New Delhi.
3. Welding handbook, American Welding Society, 1987, 8th edition, volume 1 & 2, USA R S Parmar
4. Welding process and technology, Khanna Publisher, New Delhi.
5. Friction Stir Welding and Processing, Rajiv Sharan Mishra, Partha Sarathi De, Nilesh Kumar, Springer, ISBN: 978-3-319-07042-1 (Print)
6. Friction Stir Welding and Processing, R.S. Mishra and M.W. Mahoney, ASM International, 2007, ISBN: 978-0-87170-840-3
7. Advances in Friction-Stir Welding and Processing, *M-K Besharati-Givi and P. Asadi*, Elsevier, ISBN: 978-0-85709-454-4

Course Outcome:

After learning the course the students should be able to:-

- Understand latest Power source technology & their effect on the property of the welded joint.
- Apply knowledge on selection of welding Electrodes & Gas mixtures suitable for the material.
- Explain the recent developments in Solid State welding processes and its applications.
- Explain the Modification of Fusion Welds for Increased Fatigue Resistance by Friction stir Processing.
- Explain importance of process developments in GTAW & GMAW Processes to overcome the quality & productivity issues with welded joint.
- Explain the significance of automation in welding & application area.

List of Experiments:

1. To study & understand different Power source technology used in Arc Welding.
2. To study and demonstrate Friction stir welding of dissimilar metal joints.
3. To study and demonstrate ability of Vertical milling machine in Modification of Fusion Welds for Increased Fatigue Resistance by Friction stir Processing.
4. To study various shielding Gas Mixtures & their effect on the Productivity & Quality of the weld produced.
5. To study the specifications of electrodes / filler wires used in welding.
6. To study Narrow Gap Welding Technique.
7. To study effect of Heat Input & interpass temperature on Property of the welded joint.

Design based Problems (DP)/Open Ended Problem:

- Charts demonstrating intelligent systems in welding
- Charts demonstrating Welding automation-Robotic welding.
- Selection of filler wire & shielding Gas for specialty metals & alloys.
- Charts demonstrating Electrical characteristics of Power Sources.

Major Equipment: TIG Welding Machine, MIG/MAG Welding Machine, Modified Vertical milling machine for FSW&P etc.

List of Open Source Software/learning website:

1. www.nptel.iitm.ac.in
2. <https://www.btechguru.com>
3. <http://eagar.mit.edu/EagarPapers/Eagar138.pdf>
4. <http://www.techno4india.com/arc.pdf>
5. <http://www.millerwelds.com/pdf/Paralleling.pdf>
6. http://www.esabna.com/EUWeb/AWTC/Lesson1_1.htm
7. http://teacher.buet.ac.bd/shabnam/14250_ch3.pdf
8. <http://ebookbrowse.com/chapter2-manual-metal-arc-welding-pdf-d79324541>
9. <http://www.esab.ch/de/de/support/upload/XA00136020-Submerged-Arc-Ildinghandbook.pdf>
10. <http://eagar.mit.edu/EagarPapers/Eagar061.pdf>
11. http://www.millerwelds.com/resources/tech_tips/TIG_tips/setup.html