WELDING METALLURGY

Course Type	Course Code	Name of Course	L	T	P	Credit
DE	FMD 402	Welding Metallurgy	3	0	0	9

Course Objective
The main objective of the course is to understand various joining processes used in industries for metallic materials and their effect on microstructure and mechanical properties
Learning Outcomes
• On completion of this course, students will be able to choose a particular joining process for industrial application • Understand the metallurgical aspects of welding • Able to modify the welding conditions to obtain favorable microstructural and mechanical properties

Unit No	Topics to be covered	Lecture Hours	Learning Outcome
1	**Fusion Welding Processes:** Introduction, Heat input, Power density Oxyacetylene Welding, Shielded Metal Arc Welding, Gas–Tungsten Arc Welding, Plasma Arc Welding, Gas–Metal Arc Welding, Flux-Core Arc Welding, Electron Beam Welding, Laser Beam Welding.	6	A comprehensive introduction to the course content will be delivered. Learn about different types of fusion welding processes, classification based on the heat input, power density, etc.
2	**Heat Flow in Welding**: Heat Source, Analysis of Heat Flow in Welding, Effect of Welding Parameters, Weld Thermal Simulator and its application, HAZ simulation, and various models used.	6	Students will learn the effect of different weld parameters on the weld pool formation and various mathematical models to predict and physical simulation of weld thermal cycles
3	**Residual Stresses, Distortion, and Fatigue in welded components**	4	Students will learn about the importance of stress development in the component in the weld and its effects on failure
4	**Weld Metal Solidification**: Basic solidification concepts, Epitaxial Growth at Fusion Boundary, Nonepitaxial Growth at Fusion Boundary, Competitive Growth in Bulk Fusion Zone, Effect of Welding Parameters on Grain Structure, Weld Metal Nucleation Mechanisms, Grain Structure Control, Solidification Modes and effect of constitutional supercooling, Effect of cooling rate and thermal gradient on microstructure evolution, Establishing solidification path for weld fusion zone	8	Students will learn about the metallurgical aspect of weld bead microstructure formation and the way to control the solidification behavior
5	**Weld Metal Chemical Inhomogeneities**: Microsegregation, Banding, Macrosegregation in Bulk Weld Metal, Inclusion and Porosity	4	Students will learn about the generation of segregation and chemical inhomogeneities during welding
6	**Weld defects:** Solidification Cracking: Metallurgical Factors, Mechanical Factors, Characteristics, Cause, and Testing, Liquation Mechanisms, Hydrogen Cracking	6	Students will learn about the different weld defects and their mechanism of formation
7	**Welding of advanced materials:** Aluminium alloys, Ni-based alloys, Alloy steels, etc	5	Students will learn about the different problems and solutions encountered during the welding of advanced materials
8	**Solid-state joining process**: Friction stir welding, Friction welding, Ultrasonic welding	3	Students will learn about the different solid-state welding process
	Total	**42**	

Textbooks:

S. No.	Resource/Book Name	Author(s)/Editor(s)	Publisher
1	Welding metallurgy	Sindo Kou	A John Wiley & Sons, Inc., Publication, Second Edition
2	Metallurgy of Welding	J. F. Lancaster	Springer Netherlands, ISBN: 9789401095068
3	Introduction to the Physical Metallurgy of Welding	Kenneth Easterling	Butterworth-Heinemann; 2nd edition

References:

S. No.	Resource/Book Name	Author(s)/Editor(s)	Publisher
1	Welding Metallurgy and Weldability of Stainless Steels	John C. Lippold, Damian J. Kotecki	A John Wiley & Sons, Inc
2	Welding Metallurgy and Weldability of Nickel-Base Alloys	John C. Lippold, Samuel D. Kiser, John N. DuPont	**A John Wiley & Sons, Inc, ISBN: 9781118210031**
3	Welding Metallurgy of Stainless Steels	G. Rabensteiner, Erich Folkhard, E. Perteneder, H. Schabereiter, J. Tösch	Springer , ISBN: 9783709189658 ·
4	Welding Metallurgy and Weldability	John C. Lippold	A John Wiley & Sons, Inc, ISBN: 9781118230701
5	Friction Welding: Thermal and Metallurgical Characteristics	Bekir Sami Yilbas, Ahmet Z. Sahin	Springer-Verlag Berlin and Heidelberg GmbH & Co. K; 2014th edition