LNMIIT, Jaipur
Department of Mechanical & Mechatronics Engineering
Industrial Welding (MM-INWE)

Programme: B. Tech.(MME), PhD	**Course Title:** Industrial Welding			**Course Code:** MME-INWE
Type of Course: Program Elective	**Prerequisites:** MME211, Manufacturing Technology-I or equivalent having a fundamental knowledge of Welding Technology			**Total Contact Hours:** 70
Year/Semester: 4/Even	**Lecture Hrs/Week:** 3	**Tutorial Hrs/Week:** 0	**Practical Hrs/Week:** 2	**Credits:** 4

Learning Objective:

Welding is the most economical and efficient way for permanently joining most of the industrial materials. It is the most efficient way of joining similar or dissimilar materials to make them act as a single piece. Nearly everything used in our daily life is welded or made by equipment that is welded. Welding is vital to our economy. It is often said that over 50% of the gross national product of the industrially advanced nations is related to welding in one-way or another. Welding ranks high among industrial processes and involves more sciences and variables than those involved in any other industrial process.

Welding Engineers employ their extensive knowledge of physics, engineering, metallurgy, materials, welding, and standards to design, examine, and evaluate welds as well as to plan, supervise, and document welding operations in accordance with relevant codes, contracts or drawings. The role of the Welding Engineer is critical to the integrity of the vast number of buildings, vehicles, machinery and products that require welds.

The objective of this course is to introduce the Industrial Applications of welding in such a manner that they find themselves competent to handle all kinds of challenges and bottlenecks be it in underwater welding / welding in space, welding in nuclear power plants, welding of rails for high-speed trains, being faced by our fabrication industry in welding a safe welded structure.
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Course outcomes (COs):

On completion of this course, the students will have the ability to:		**Bloom's Level**
CO-1	**Identify** & **describe** welding procedures, processes, and documentation.	**1, 2**
CO-2	**Apply** welding procedure qualifications and generate welding procedures **Illustration** for the manufacturing and welding teams.	**3, 4**
CO-3	**Apply** & **Examine** failure analyses and cause analyses on welding issues	**3, 4**
CO-4	**Examine** & **Evaluate** engineering designs for welding requirements	**4, 5**

Course content

S. No.	Topics	Lecture
1.	Introduction to importance of welding in fabrication, Problems & difficulties in welded structures, how to obtain a sound welded structures and analysis.	3
2.	Properties for selection of materials, Characteristic properties and behaviour of commonly used materials, Effect of alloying elements.	4
3.	Heat flow in welds, Heating and cooling cycles in welding, Effect on HAZ, Hot cracking, Development of phases, microstructure etc.	3
4.	Causes and cures for various discontinuities & defects in weldments.	4
5.	Weldability, Weldability of commonly used materials, Mechanical testing of weldments, Service and fabrication weldability tests and their importance.	5
6.	Thermal stresses and distortion.	2
7.	Brittle fracture and fatigue in welded joints.	2
8.	NDE of welds.	3
9.	Joint preparation and weld symbols.	3
10.	Joining metallurgy and microstructures.	4
11.	Welding Procedures	2
12.	Qualification of Welders and Operators	4
13.	Cost analysis of welded joints.	2
14.	Welding Codes & Standards	1
	TOTAL	**42**

Practical

S. No.	Topics	Laboratory /	
	Experimental Content	Sessions	hr.
1.	1. The effect of direct and indirect welding parameters for SMAW, SAW, GMAW, GTAW and PESMAW processes on: 2. The effect of direct and indirect welding parameters on 'weld bead geometry and shape relationships [BG&SR]. 3. Effect of heat input on heat affected zone [HAZ]. 4. Loss and gain of elements due to pyro-chemical reactions and basicity index of the consumables. 5. Effect of flux composition on weld metal chemistry. 6. Effect of heat input and cooling rate on microstructure and hardness.	7	14
Analysis Part			

2.	1. Statistical design of experiments. 2. Cutting, metallurgical polishing and etching of specimens. 3. Recording of BG&SR, tabulation and measurement of various BG&SR parameters including the extent of heat affected zone. 4. Microstructural and microhardness investigations. 5. Developing correlations between the various responses and welding parameters. 6. Interpretation and analysis of results.	7	14
	Total Laboratory Sessions	**14**	**28**

Recommended books and reading material

1. Welding Metallurgy, J. F. Lancaster, Abington Publishing, Cambridge, England.
2. Metallurgy of Welding, J. F. Lancaster, Abington Publishing, Cambridge, England.
3. Analysis of Welded Structures Koichi Masubuchi Pergamon Press.
4. Welding, Brazing and Soldering, Volume-6 ASM Handbook ASM International, USA.
5. Welding Handbook, Volume1,2,3,4,5 American Welding Society (AWS).
6. Engineering Physical Metallurgy Y. S. Lakhtin MIR Publishers, Moscow.
7. Materials Science and Engineering, an Introduction William D. Callister, Jr. John Wiley & Sons, Inc.

Additional Resources: NPTEL, MIT Video Lectures, Web resources etc.

Evaluation Method	
Item	**Weightage (%)**
Assignments	10
Quizzes	10
Midterm	30
Final Examination	50

CO and PO Correlation Matrix (MME)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	1	3								3		1
CO2	2	2	2	1	3								2		1
CO3	2	2	2	1	3								2		1
CO4	2	2	2	3	3								2		2

Prepared by: Prof. Sunil Pandey
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