



GOVERNMENT COLLEGE OF ENGINEERING, SALEM
(NAAC Accredited with A⁺, An Autonomous Institution, Affiliated to Anna University, Chennai)

POSTGRADUATE CURRICULUM

(Applicable to the students admitted in M.E. Programme, from the Academic Year 2026-2027)

Programme: M.E. Welding Technology

Regulations: 2026

Overview of Credits

Sem	BS	ES(PC)	ES(PE)	SD	MC	AC	Total
I	4	14		1	3	0	22
II		14	6			0	20
III			6	8			14
IV				14			14
Total	4	28	12	23	3	0	70
% of Category	5.71	40.00	17.14	32.86	4.29	0	100

Abbreviations:

Course Type:

T - Theory
L - Laboratory
PW -Project Work

Category :

BS - Basic Science
ES - Engineering Science [Programme Core(**PC**)
Programme Elective(**PE**)]
SD - Skill Development
MC -Mandatory Course
AC- Audit Course

Others :

TCP -Total Contact Periods
L - Lecture
T - Tutorial
P - Practical

Semester I											
Sl. No.	Course Code	Course Name	Course Type	Hours per Semester				Credits	Category	Weightage	
				L	T	P	TCP			CA %	ES %
1.	26MP103	Advanced Mathematics and Statistics	T	45	15	0	60	4	BS	40	60
2.	26WT101	Materials Technology	T	45	0	0	45	3	ES(PC)	40	60
3.	26WT102	Joining Processes – I	T	45	0	0	45	3	ES(PC)	40	60
4.	26WT103	Metallurgy of Welding	T	45	15	0	60	4	ES(PC)	40	60
5.	26MLC01	Research Methodology and IPR	T	45	0	0	45	3	MC	40	60
6.	26WT104	Metallography Laboratory	L	0	0	60	60	2	ES(PC)	60	40
7.	26WT105	Joining Laboratory	L	0	0	60	60	2	ES(PC)	60	40
8.	26WT106	Technical Seminar	-	0	0	30	30	1	SD	100	0
9.	26AC00X	Audit course - I	T	30	0	0	30	0	AC	100	0
Total							435	22			

Semester II											
Sl. No.	Course Code	Course Name	Course Type	Hours per Semester				Credits	Category	Weightage	
				L	T	P	TCP			CA %	ES %
1.	26WT201	Joining Processes – II	T	45	0	0	45	3	ES(PC)	40	60
2.	26WT202	Joining and Allied Processes	T	45	15	0	60	4	ES(PC)	40	60
3.	26WT203	Design of Weldments	T	45	0	0	45	3	ES(PC)	40	60
4.	26WTEXX	Programme Elective - I	T	45	0	0	45	3	ES(PE)	40	60
5.	26WTEXX	Programme Elective - II	T	45	0	0	45	3	ES(PE)	40	60
6.	26WT204	Quality Control in Weldments Laboratory	L	0	0	60	60	2	ES(PC)	60	40
7.	26WT205	Materials Characterization Laboratory	L	0	0	60	60	2	ES(PC)	60	40
8.	26AC00X	Audit course - II	T	30	0	0	30	0	AC	100	0
Total							390	20			

Semester III											
Sl. No.	Course Code	Course Name	Course Type	Hours per Semester				Credits	Category	Weightage	
				L	T	P	TCP			CA %	ES %
1.	26WTEXX	Programme Elective - III	T	45	0	0	45	3	ES(PE)	40	60
2.	26WTEXX	Programme Elective - IV	T	45	0	0	45	3	ES(PE)	40	60
3.	26WT301	Dissertation Phase - I	PW	0	0	240	240	8	SD	60	40
Total							330	14			

Semester IV											
Sl. No.	Course Code	Course Name	Course Type	Hours per Semester				Credits	Category	Weightage	
				L	T	P	TCP			CA %	ES %
1.	26WT401	Dissertation Phase – II	PW	0	0	420	420	14	SD	60	40
Total							420	14			
Total Credits for the Programme = 22+20+14 +14								70			

Programme Electives

Sl. No.	Course Code	Course Name	Course Type	Hours per Semester				Credits	Category	Weightage	
				L	T	P	TCP			CA %	ES %
Programme Elective - I (Semester II)											
1.	26WTE01	Testing and Inspection of Weldments	T	45	0	0	45	3	ES(PE)	40	60
2.	26WTE02	Electrical Aspects of Welding	T	45	0	0	45	3	ES(PE)	40	60
3.	26WTE03	Welding Application Technology	T	45	0	0	45	3	ES(PE)	40	60
4.	26WTE04	Foundry Processes	T	45	0	0	45	3	ES(PE)	40	60
Programme Elective - II (Semester II)											
5.	26WTE05	Materials Characterization	T	45	0	0	45	3	ES(PE)	40	60
6.	26WTE06	Finite Element Analysis	T	45	0	0	45	3	ES(PE)	40	60
7.	26WTE07	Industrial Safety	T	45	0	0	45	3	ES(PE)	40	60
8.	26WTE08	Repair welding and Reclamation	T	45	0	0	45	3	ES(PE)	40	60
Programme Elective - III (Semester III)											
9.	26WTE09	Total Quality System and Engineering	T	45	0	0	45	3	ES(PE)	40	60
10.	26WTE10	Automation and Robots in Welding	T	45	0	0	45	3	ES(PE)	40	60
11.	26WTE11	Welding Codes and Standards	T	45	0	0	45	3	ES(PE)	40	60
12.	26WTE12	Additive Manufacturing	T	45	0	0	45	3	ES(PE)	40	60
Programme Elective - IV (Semester III)											
13.	26WTE13	Corrosion and Surface Engineering	T	45	0	0	45	3	ES(PE)	40	60
14.	26WTE14	Composite Materials	T	45	0	0	45	3	ES(PE)	40	60
15.	26WTE15	Non-Metallic Materials	T	45	0	0	45	3	ES(PE)	40	60
16.	26WTE16	Failure Analysis in Weldments	T	45	0	0	45	3	ES(PE)	40	60

Audit Courses

Sl. No.	Course Code	Course Name	Course Type	Hours per Semester				Credits	Category	Weightage	
				L	T	P	TCP			CA %	ES %
1.	26AC001	English for Research paper writing	T	30	0	0	30	0	AC	100	0
2.	26AC002	Disaster Management	T	30	0	0	30	0	AC	100	0
3.	26AC003	Sanskrit for Technical Knowledge	T	30	0	0	30	0	AC	100	0
4.	26AC004	Value Education	T	30	0	0	30	0	AC	100	0
5.	26AC005	Constitution of India	T	30	0	0	30	0	AC	100	0
6.	26AC006	Pedagogy Studies	T	30	0	0	30	0	AC	100	0
7.	26AC007	Stress Management by Yoga	T	30	0	0	30	0	AC	100	0
8.	26AC008	Personality Development through Life Enlightenment Skills	T	30	0	0	30	0	AC	100	0
9.	26AC009	Sustainable Development Goals	T	30	0	0	30	0	AC	100	0

26MP103	ADVANCED MATHEMATICS AND STATISTICS M.E. (Welding Technology)			SEMESTER		I	
Prerequisites			Category	BS	Credits		4
Basic knowledge of calculus, matrices, differential equations and probability concepts is required.			Hours/ Semester	L	T	P	TH
				45	15	0	60
COURSE OBJECTIVES							
1.	Apply least squares and numerical techniques to fit curves and solve engineering equations.						
2.	Implement Laplace and Fourier transform techniques for solving partial differential equations.						
3.	Analyze statistical data using hypothesis testing based on standard probability distributions.						
4.	Apply analysis of variance and principles of design of experiments to interpret experimental results.						
5.	Develop the ability to model and solve engineering problems using analytical, numerical and statistical tools.						
UNIT - I		CURVE FITTING AND SOLUTION OF EQUATIONS					9+3
Curve fitting by the Method of Least Squares –Fitting of straight lines, second-degree parabolas and curves reducible to linear forms – Solution of Algebraic and Transcendental equations by Newton-Raphson Method – Solutions of linear system of equations by Gauss Elimination, Gauss-Jordan and Gauss-Seidel methods.							
UNIT - II		LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS					9+3
Laplace transform: Definitions – Properties – Inverse Laplace transform – Solution of one-dimensional diffusion and wave equations using Laplace transform techniques.							
UNIT - III		FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS					9+3
Fourier transform: Definitions – Properties- Fourier transforms of elementary functions– Solution of diffusion equation, wave equation and Laplace equation using Fourier transform techniques.							
UNIT - IV		TESTING OF HYPOTHESIS					9+3
Sampling distributions – Small and large samples – Tests based on Normal, t, Chi square, and F distributions for testing of means, variance and proportions – Analysis of $r \times c$ Contingency Tables – Goodness-of-Fit Tests – Tests for Independence of Attributes.							
UNIT - V		ANALYSIS OF VARIANCE AND DESIGN OF EXPERIMENTS					9+3
Analysis of variance – One way and Two-way classifications – Principles of Design of Experiments – Standard Experimental Designs (Completely Randomized Design, Randomized Block Design and Latin Square Design).							
L:45, T: 15, P: 0, Total: 60 Hours							
Weightage: Continuous Assessment: 40% End Semester Examinations: 60%							
REFERENCE BOOKS:							
1.	Kandaswamy, P., Thilagavathy, K. and Gunavathi, K., "Numerical Methods", S. Chand Publishing, New Delhi. 2010.						
2.	Sankara Rao, K., "Introduction to Partial Differential Equations", 1 st Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2003.						
3.	Veerarajan, T.,"Probability, Statistics and Random Processes", 2 nd Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2002.						
4.	Gupta, S. C., and Kapoor, V. K., "Fundamentals of Mathematical Statistics", 11 th Edition, S. Chand & Sons, New Delhi, 2014.						
5.	Devore, Jay L., "Probability and Statistics for Engineering and the Sciences", 9 th Edition, Cengage Learning, 2016.						

E-RESOURCES:

1.	NPTEL – Numerical Methods https://nptel.ac.in/courses/111/106/111106101		
2.	MIT OCW – Introduction to Numerical Methods https://ocw.mit.edu/courses/18-335j-introduction-to-numerical-methods-spring-2019/		
3.	NPTEL – Laplace Transforms & Applications https://nptel.ac.in/courses/111/102/111102113		
4.	NPTEL – Fourier Transforms & Their Applications https://nptel.ac.in/courses/111/102/111102114		
5.	NPTEL – Probability & Statistics https://nptel.ac.in/courses/111/105/111105041		

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain Laplace and Fourier transform concepts, curve fitting principles, probability distributions, hypothesis testing, ANOVA and experimental design methods.	PO3	PSO1
CO2	Apply least squares curve fitting and Laplace/Fourier transform techniques to solve engineering problems and partial differential equations.	PO1, PO3	PSO1
CO3	Analyze engineering systems and data using transform methods, curve fitting, statistical distributions, hypothesis testing, and ANOVA for decision making.	PO1, PO3	PSO1, PSO2
CO4	Evaluate and select appropriate statistical and mathematical techniques, including hypothesis testing, ANOVA, design of experiments, curve fitting, and transform methods, for engineering problem solving and decision making.	PO1, PO3	PSO2
CO5	Develop mathematical and statistical models for engineering applications using curve fitting, transform methods, hypothesis testing, and ANOVA, and effectively communicate the results through technical reports and presentations.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	2	2	-
CO2	3	-	3	3	-
CO3	3	-	3	3	3
CO4	2	-	2	-	2
CO5	2	2	2	2	2
Average	2.5	2	2.4	2.5	2.3

Activities:

1.	Develop a program to perform least square curve fitting and solve nonlinear equations using Newton–Raphson method.
2.	Solve the one-dimensional diffusion or wave equation using Laplace transform and verify the solution using analytical or graphical interpretation.
3.	Apply Fourier transform to solve diffusion or Laplace equation and interpret the physical meaning of the solution.
4.	Perform hypothesis testing for mean, variance or proportion using t-test, chi-square test or F-test for given data.
5.	Analyze experimental data using one-way or two-way ANOVA and recommend the most suitable experimental design.

Rubrics for evaluation: CO4
(Evaluation of Statistical and Mathematical Methods for Engineering Problems)

Sl. No.	Criterion	Marks	Excellent (7-8)	Good (4-6)	Satisfactory (1-3)
1.	Understanding of Statistical and Mathematical Methods	8	Demonstrates strong understanding of statistical and mathematical methods and their applicability	Shows adequate understanding with minor gaps	Demonstrates limited understanding
2.	Selection and Justification of Suitable Method	8	Appropriate statistical/mathematical method selected with clear and logical justification	Suitable method selected with minor issues in justification	Incorrect or unclear method selection
3.	Execution of Mathematical and Statistical Analysis	8	Analysis is carried out correctly using appropriate procedures and techniques	Minor errors in applying procedures or techniques	Major errors in analysis methodology
4.	Accuracy, Validity and Interpretation of Results	8	Results are accurate, valid, and appropriately interpreted for the given problem	Minor computational, analytical, or interpretation errors	Major errors affecting validity and interpretation
5.	Technical Presentation and Communication	8	Work is systematic, well-organized, and professionally presented with clear conclusions	Presentation is adequate with minor organizational issues	Poorly organized presentation and communication of results
	Total	40			

Rubrics for evaluation: CO5
(Development of Mathematical and Statistical Models for Engineering Solutions)

Sl. No.	Criterion	Marks	Excellent (7-8)	Good (4-6)	Satisfactory (1-3)
1.	Problem Formulation and Mathematical/Statistical Modelling	8	Engineering problem is clearly formulated with an appropriate mathematical/statistical model	Minor issues in formulation or modelling	Problem formulation and modelling are unclear
2.	Selection of Mathematical/Statistical Method	8	Appropriate mathematical/statistical method is selected with clear justification	Suitable method selected with minor issues	Inappropriate or unclear method selection
3.	Methodology and Solution Development	8	Mathematical/statistical procedures are correctly developed and systematically implemented	Methodology is adequate with minor errors	Incorrect or incomplete methodology

4.	Solution Accuracy and Validation	8	Solutions are accurate and properly verified or validated	Validation is adequate with minor issues	Poor or incomplete validation of solutions
5.	Analysis, Engineering Interpretation and Technical Presentation	8	Results are effectively analyzed, related to engineering applications, and communicated through clear, well-organized reports and presentations	Interpretation and presentation are adequate with minor issues	Poor interpretation, presentation, and documentation
	Total	40			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24	-	-	24	3
CO3	24	24	-	-	24	3
CO4	-	-	40		20	2
CO5	-	-		40	20	2
Total	60	60	40	40	100	

Note: Strength = 3 (if percentage >20%); Strength= 2 (if percentage 10% to 20%);
Strength = 1 (if percentage <10%)

Weightage:

Continuous Assessment 40%

End Semester Examinations 60%

REFERENCE BOOKS:

1.	Raghavan V., <i>Physical Metallurgy: Principles and Practice</i> , 2nd Edition, PHI Learning, 2011.
2.	William D. Callister Jr. and David G. Rethwisch, <i>Materials Science and Engineering: An Introduction</i> , 10th Edition, Wiley, 2018.
3.	Flinn R.A. and Trojan P.K., <i>Engineering Materials and Their Applications</i> , 4th Edition, Jaico Publishing House, 1999.
4.	Kenneth G. Budinski and Michael K. Budinski, <i>Engineering Materials: Properties and Selection</i> , 9 th Edition, Pearson, 2010.
5.	ASM Handbook, Volumes 1, 2 and 4, 10th Edition, ASM International, 2018.
6.	Rajan T.V., Sharma C.P. and Sharma A., <i>Heat Treatment: Principles and Techniques</i> , PHI Learning, 2009.
7.	Vijendra Singh, <i>Heat Treatment of Metals</i> , Standard Publishers, 1998.
8.	Romesh C. Sharma, <i>Principles of Heat Treatment of Steels</i> , New Age International Publishers, 2002.

E-RESOURCES:

1.	NPTEL – Physical Metallurgy.
2.	NPTEL – Materials Science and Engineering.
3.	ASM International Digital Library.
4.	Springer Materials Database.
5.	ScienceDirect – Materials Science Journals.

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain phase diagrams, microstructural transformations, ferrous alloys, non-ferrous alloys and heat treatment processes used in engineering applications.	-	-
CO2	Apply phase diagram concepts, alloy selection principles and heat treatment techniques for engineering materials.	PO1	PSO2
CO3	Analyze the relationship between composition, microstructure, processing and properties of ferrous and non-ferrous alloys.	PO1	PSO1
CO4	Evaluate heat treatment and case hardening processes for achieving desired mechanical and metallurgical properties.	PO2, PO3	PSO1, PSO2
CO5	Develop suitable material selection and heat treatment strategies for advanced engineering and welding applications.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			2	3	
CO3	2		1	3	
CO4	2	2	1	3	1
CO5	3	2	3	3	2

Activities:

1.	Activity I (CO4): Technical Poster Presentation on Engineering Materials and Heat Treatment Technologies
2.	Technical Seminar Presentation on Advanced Engineering Materials and Heat Treatment (Independent Study)

Rubrics for evaluation: CO4 (Technical Poster Presentation)

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content
2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization
3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information
5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication
	Total	100			

Rubrics for evaluation: CO5 (Technical Seminar Presentation)

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Topic Selection & Literature Review	20	Recent and highly relevant topic with good literature support	Relevant topic	Basic topic

2.	Technical Understanding	20	Demonstrates excellent conceptual understanding	Good understanding	Limited understanding
3.	Industrial Applications / Case Study	20	Well-supported with industrial examples and technical discussion	Adequate examples	Few examples
4.	Technical Report Preparation	20	Professional report with proper references and formatting	Good report	Incomplete report
5.	Seminar Presentation & Interaction	20	Excellent presentation, confidence, and response to questions	Good presentation	Poor communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Strength = 3 (if percentage >20%); Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%).

26WT102	JOINING PROCESSES -I		SEMESTER		I	
Prerequisites		Category	ES(PC)	Credits	3	
Physics and Manufacturing Processes		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To understand the various welding processes.					
2.	To gain knowledge on the principle of operation, advantages, limitations and applications of various welding processes.					
3.	To suggest appropriate welding processes for applications.					
UNIT - I		INTRODUCTION TO JOINING PROCESSES				9
Introduction & Importance of welding, comparison of welding with other fabrication processes. Classification of welding processes. Terminology in welding, Heat sources for fusion welding, shielding methods. Welding Arc, Arc physics, physical phenomena occurring in the arc, potential distribution, brief ideas of heat generations, types of forces and metal transfer. Arc blow-Causes and methods of elimination. Heat input and Energy density.						
UNIT - II		WELDING MACHINES AND GAS WELDING				9
Types of power sources – Generators, Transformers, Rectifiers and Inverters. Types of welding current and polarity. Open circuit voltage (OCV), Duty cycle. Static Volt-Ampere characteristics. Measurement of Welding current, voltage and temperatures, variation of current and voltage with arc length, arc length control. Safety in Welding. Oxy-Fuel Gas Welding: Gases. Oxy-acetylene welding (OAW) - setup of equipment, Flame characteristics, different kinds of flame and their applications, Variants of oxy fuel gas welding.						
UNIT - III		SHIELDED METALARC WELDING (SMAW) AND SUBMERGED ARC WELDING (SAW)				9
SMAW Process: Principle of the process, Electrodes, functions of flux coating, types of electrodes based on flux covering, AWS Classifications of electrodes, Arc welding defects. Advantages, limitations and applications of SMAW process. Submerged arc welding – Principle of the process, Equipment, Flux classification, Basicity index, Introduction to electrode-flux combinations. Variations of the Process. Defects. Advantages, limitations and Applications.						
UNIT - IV		GAS TUNGSTEN ARC WELDING (GTAW) and PLASMA ARC WELDING (PAW)				9
Gas Tungsten Arc Welding: Equipment, Tungsten electrode and its types. Effect of polarity, shielding gases, use of D.C. suppressors, arc starting and stopping, filler rods. Use of pulsed arc and GTA spot welding, other recent developments. Defects. Advantages, limitations and applications. Plasma arc welding: Equipment, Operating modes – melt- in technique, key-hole technique. Transferred arc and non-transferred arc. Micro, low and high current plasma arc welding. Defects. Advantages, limitations and applications.						
UNIT - V		GAS METAL ARC WELDING (GMAW) and FLUX CORED ARC WELDING (FCAW)				9
Gas Metal Arc Welding - Principle of the process, Equipment, shielding gases. Metal transfer mechanisms. Filler wires. Pulsed GMAW, Synergic GMAW, Cold Metal Transfer. Defects. Advantages, limitations and applications. Flux cored arc welding: – Process features, Self-shielded and Flux-shielded FCAW. Tubular electrode manufacture and Electrode classification. Defects. Advantages, limitations and applications.						
L:45, Total:45 Hours						

Weightage: Continuous Assessment 40% End Semester Examinations 60%					
REFERENCE BOOKS:					
1.	Cary Howard B. and Scott Helzer, Modern Welding Technology, 7th Edition, Pearson Education, 2021.				
2.	Larry Jeffus, Welding: Principles and Applications, 9th Edition, Cengage Learning, 2020.				
3.	Sindo Kou, <i>Welding Metallurgy</i> , 3rd Edition, Wiley, 2021.				
4.	R. S. Parmar, <i>Welding Engineering and Technology</i> , 3rd Edition, Khanna Publishers, 2020.				
5.	J. F. Lancaster, <i>The Physics of Welding</i> , 2nd Edition, Pergamon Press.				
6.	AWS Welding Handbook, Volume 1: Welding Science and Technology, 9th Edition.				
E-RESOURCES:					
1.	NPTEL Course on Welding Technology.				
2.	American Welding Society (AWS) Learning Resources.				
3.	Welding Research Council Technical Publications.				
4.	ScienceDirect – Welding and Joining Journal Collection.				
5.	SpringerLink – Welding Engineering and Fabrication Resources.				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to			Mapping POs	Mapping PSOs	
CO1	Explain the fundamentals of welding, welding arc characteristics, welding power sources, gas welding, and the principles of various arc welding processes.		-	-	
CO2	Apply the operating principles of welding power sources, gas welding, SMAW, SAW, GTAW, PAW, GMAW and FCAW for appropriate welding applications.		PO1	PSO2	
CO3	Analyze the selection of welding processes, welding parameters, consumables, shielding methods, defects, and process limitations for different engineering applications.		PO1	PSO1	
CO4	Evaluate the suitability of welding processes based on process characteristics, weld quality, equipment, productivity, and industrial application requirements.		PO2, PO3	PSO1, PSO2	
CO5	Recommend suitable welding processes, consumables, and operating conditions to achieve quality weldments for various fabrication and manufacturing applications.		PO1, PO2, PO3	PSO1, PSO2	
The Course Articulation Matrix (CAM) for defined COs					
	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2	3				2
CO3	3			2	
CO4		3	3	2	2
CO5	3	3	3	3	3

Activities:

1.	Activity I (CO4):Technical Poster Presentation on Conventional Welding Processes
2.	Activity I (CO5):Technical Seminar Presentation on Recent Developments in Arc Welding Processes (Independent Study)

Rubrics for evaluation: (CO4): Technical Poster Presentation on Conventional Welding Processes

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content
2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization
3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information
5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Topic Selection & Literature Review	20	Recent and highly relevant topic with good literature support	Relevant topic	Basic topic
2.	Technical Understanding	20	Demonstrates excellent conceptual understanding	Good understanding	Limited understanding
3.	Industrial Applications / Case Study	20	Well-supported with industrial examples and technical discussion	Adequate examples	Few examples

4.	Technical Report Preparation	20	Professional report with proper references and formatting	Good report	Incomplete report
5.	Seminar Presentation & Interaction	20	Excellent presentation, confidence, and response to questions	Good presentation	Poor communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Strength = 3 (if percentage >20%); Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%).

26WT103	METALLURGY OF WELDING		SEMESTER		I	
Prerequisites		Category	ES(PC)	Credits	4	
Manufacturing Processes, Materials processing		Hours/ Semester	L	T	P	TH
			45	15	0	60
COURSE OBJECTIVES						
1.	Illustrate the heat flow in welding, structures formed and effect of various welding parameters.					
2.	List and explain the various types of weldability tests.					
3.	Discuss the weldability of carbon steel and low alloy steels and weldability issues.					
4.	Analyse the weldability of stainless steel.					
5.	Apply various welding process, procedure, and filler metal selection for the welding of cast iron, non-ferrous alloys and for dissimilar welding.					
UNIT - I		HEAT FLOW IN ARC WELDING				9+3
Heat flow – Basic heat transfer equations, temperature distributions and cooling curves. Influence of heat input, joint geometry, plate thickness, preheating and other factors. Comparison of welding processes based on thermal characteristics. Solidification – Epitaxial growth, weld metal solidification, cellular and columnar structures, effect of welding parameters, absorption of gases, gas-metal and slag-metal reactions.						
UNIT - II		WELDABILITY AND WELDABILITY TESTING				9+3
Concept of weldability, factors affecting weldability, welding defects, causes and remedies. Cracking phenomena in welding. Weldability tests – cold cracking tests, hot cracking tests, internal restraint tests, external restraint tests. Mechanical testing of weldments – types of tension tests, types of bend tests and hardness survey.						
UNIT - III		WELDABILITY OF CARBON STEELS AND LOW ALLOY STEELS				9+3
Formation of different microstructural zones in welded plain carbon steels, C-Mn steels and low alloy steels. Phase transformations in weld metal and heat affected zones. Hydrogen induced cracking, carbon equivalent, preheating, post-heating and post weld heat treatment. Hot cracking, effect of sulphur and phosphorus, reheat cracking and lamellar tearing.						
UNIT - IV		WELDABILITY OF STAINLESS STEELS				9+3
Introduction to stainless steel classification and effect of alloying elements. Austenite and ferrite stabilizing elements. Weldability of austenitic stainless steels. Hot cracking, constitution diagrams – Schaeffler, Delong and WRC diagrams. Mode of solidification, sensitization and sigma embrittlement. Metallurgical difficulties in welding ferritic, martensitic and duplex stainless steels. Selection of filler metals.						
UNIT - V		WELDABILITY OF OTHER ALLOYS AND DISSIMILAR WELDING				9+3
Welding of cast irons, high chromium steels and maraging steels. Process selection, welding procedures and filler metal selection. Weldability problems and remedies. Weldability of aluminium alloys, copper alloys, titanium alloys and nickel alloys. Selection of welding processes and procedures. Dissimilar welding – Metallurgical problems, calculation of dilution, methods of controlling dilution and techniques of dissimilar welding.						
L:45 + T:15, Total:60 Hours						

Weightage:

Continuous Assessment 40%

End Semester Examinations 60%

REFERENCE BOOKS:

1.	R.S. Parmar, <i>Welding Engineering and Technology</i> , Khanna Publishers, 2nd Edition, 2010.
2.	Linnert. G.E. —Welding Metallurgy, Vol. 1 and 2. 4 th edition. AWS. USA, 1994.
3.	J.F. Lancaster, <i>Metallurgy of Welding</i> , 6 th Edition, Woodhead Publishing, 1999.
4.	Sindo Kou, <i>Welding Metallurgy</i> , 2 nd Edition, Wiley-Interscience, 2003.
5.	H. Granjon, <i>Fundamentals of Welding Metallurgy</i> , Jaico Publishing House, 1994.
6.	Norman Bailey, <i>Weldability of Ferritic Steels</i> , Abington Publishing, 1994.
7.	AWS Welding Handbook, Volume 1: Welding Science and Technology, 9 th Edition, American Welding Society, 2011.
8.	T. DebRoy and S.A. David, <i>Welding Metallurgy and Weldability</i> , Wiley, 2011.
9.	ASM Handbook, Volume 6: Welding, Brazing and Soldering, ASM International, 2017.
10.	ASM Handbook, Volume 6A: Welding Fundamentals and Processes, ASM International, 2017.

E-RESOURCES:

1.	https://onlinecourses.nptel.ac.in/e-learning/preview/noc22_mm22
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COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain the heat flow, weldability concepts to identify weld defects and weldment performance under different restraint and loading conditions and to interpret solidification behavior, microstructural zones, phase transformations, cracking mechanisms, and heat treatment effects of various materials.	--	-
CO2	Apply the weldability of various materials to select suitable welding processes, procedures, filler metal choices, and dilution-control strategies.	PO1	PSO1
CO3	Analyze the weldability of various materials to select suitable welding processes, procedures, filler metal choices, and dilution-control strategies.	PO2,	PSO1
CO4	Submit a case study defect identified and interpret, microstructural zones, phase transformations, cracking mechanisms, and heat treatment effects of given material through self-learning activities and present the findings while considering societal and economic impacts.	PO2	PSO2
CO5	Submit a seminar on defect identified and interpret, microstructural zones, phase transformations, cracking mechanisms, and heat treatment effects of given material through self-learning activities and present the findings while considering societal and economic impacts.	PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined Cos

	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			2	3	
CO3	3		1	3	1
CO4	2	3	1	3	2
CO5	3	2	3	3	3

Activities:

1.	Activity I (CO4): Technical Poster Presentation on Weldment Microstructure and Weldability of Engineering Materials
2.	Activity II (CO5): Technical Seminar Presentation on Metallurgical Aspects of Welding and Weldability (Independent Study)

Rubrics for evaluation: CO4 (Technical Poster Presentation)

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content
2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization
3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information
5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication
	Total	100			

Rubrics for evaluation: CO5 (Technical Seminar Presentation)

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Topic Selection & Literature Review	20	Recent and highly relevant topic with good literature support	Relevant topic	Basic topic

2.	Technical Understanding	20	Demonstrates excellent conceptual understanding	Good understanding	Limited understanding
3.	Industrial Applications / Case Study	20	Well-supported with industrial examples and technical discussion	Adequate examples	Few examples
4.	Technical Report Preparation	20	Professional report with proper references and formatting	Good report	Incomplete report
5.	Seminar Presentation & Interaction	20	Excellent presentation, confidence, and response to questions	Good presentation	Poor communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Strength = 3 (if percentage >20%); Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%).

26MLC01	RESEARCH METHODOLOGY AND IPR		SEMESTER		I	
Prerequisites		Category	MC	Credits		3
NIL		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To understand the fundamentals of research methodology and scientific investigation.					
2.	To develop skills in literature survey, research design, data analysis and interpretation.					
3.	To acquire knowledge in technical writing, research proposal preparation and publication ethics.					
4.	To understand the concepts, procedures and legal aspects of Intellectual Property Rights (IPR).					
5.	To develop awareness of patents, copyrights, trademarks, geographical indications and technology transfer mechanisms.					
UNIT - I	INTRODUCTION TO RESEARCH					9
Meaning of research problem, Sources of research problem, Criteria and characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches for investigation and solution of research problems, Data collection, Analysis and interpretation, Necessary instrumentation for research.						
UNIT - II	EFFECTIVE LITERATURE STUDIES, APPROACHES AND ANALYSIS					9
Developing the theoretical framework of research, Developing operational statements of problems, Criteria for evaluating research approaches, Hypothesis formulation, Parametric and non-parametric testing, Establishing reliability and validity of findings through literature review and experimental documentation, Plagiarism, Research ethics and professional responsibilities						
UNIT - III	EFFECTIVE TECHNICAL WRITING, REPORT AND PAPER WRITING					9
Developing a research proposal, Format of research proposal, Technical report writing, Journal paper preparation, Conference paper preparation, Presentation techniques, Assessment by review committees, Research communication skills.						
UNIT - IV	NATURE OF INTELLECTUAL PROPERTY					9
Patents, Industrial Designs, Trademarks and Copyrights. Process of innovation, technological research, patenting and product development. International Scenario: International cooperation on Intellectual Property Rights. Procedure for grant of patents, Patent Cooperation Treaty (PCT), Patent filing procedures.						
UNIT - V	PATENT RIGHTS AND IPR					9
Scope of Patent Rights, Licensing and Technology Transfer, Patent Information and Databases, Geographical Indications, Administration of Patent Systems, Emerging trends in IPR, IPR in Biological Systems, Computer Software and Digital Technologies, Traditional Knowledge, Case Studies on IPR, Role of IPR in Academic and Research Institutions.						
L:45, Total:45 Hours						
Weightage:						
Continuous Assessment 40%						
End Semester Examinations 60%						

REFERENCE BOOKS:			
1.	Stuart Melville and Wayne Goddard, <i>Research Methodology: An Introduction for Science and Engineering Students</i> , Juta Academic Publishers, 2018.		
2.	Wayne Goddard and Stuart Melville, <i>Research Methodology: An Introduction</i> , Juta Academic Publishers, 2020.		
3.	Ranjit Kumar, <i>Research Methodology: A Step-by-Step Guide for Beginners</i> , 5th Edition, Sage Publications, 2024.		
4.	Deborah E. Bouchoux, <i>Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets</i> , 6th Edition, Cengage Learning, 2023.		
5.	Robert P. Merges, Peter S. Menell and Mark A. Lemley, <i>Intellectual Property in the New Technological Age</i> , 2021 Edition, Clause 8 Publishing, 2021.		
6.	T. Ramappa, <i>Intellectual Property Rights under WTO</i> , S. Chand Publications, 2019.		
7.	Halbert Deborah, <i>Resisting Intellectual Property</i> , Routledge, 2007.		
E-RESOURCES:			
1.	NPTEL – Research Methodology.		
2.	NPTEL – Intellectual Property Rights.		
3.	WIPO Academy Courses – World Intellectual Property Organization.		
4.	Indian Patent Office – Patent Information System.		
5.	Shodhganga and Shodhgangotri Research Repository.		
6.	Springer Nature Researcher Academy.		
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain research methodologies, literature review techniques, technical writing practices, intellectual property concepts and patent systems.		
CO2	Apply research methods, data collection techniques, hypothesis testing and technical documentation procedures in engineering research.	PO1	PSO2
CO3	Analyze research problems, literature findings, experimental results and intellectual property issues related to innovation and technology development.	PO1	PSO1
CO4	Evaluate research outcomes, publication quality, ethical practices, patentability and intellectual property protection strategies.	PO2, PO3	PSO1, PSO2
CO5	Develop research proposals, technical reports, patent documentation and technology commercialization strategies for engineering applications.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

	P01	P02	P03	PS01	PS02
CO1					
CO2			2		
CO3	3		1		
CO4	3	3	1		
CO5	3	3	2		1

Activities:

1.	Activity I (CO4): Technical Poster Presentation on Research Methodology, Research Ethics and Intellectual Property Rights
2.	Activity II (CO5): Technical Seminar Presentation on Research Proposal and Emerging Trends in Intellectual Property Rights (Independent Study)

Rubrics for evaluation: CO4 (Technical Poster Presentation)

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content
2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization
3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information
5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication
	Total	100			

Rubrics for evaluation: CO5 (Technical Seminar Presentation)

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Topic Selection & Literature Review	20	Recent and highly relevant topic with good literature support	Relevant topic	Basic topic
2.	Technical Understanding	20	Demonstrates excellent conceptual understanding	Good understanding	Limited understanding
3.	Industrial Applications / Case Study	20	Well-supported with industrial examples and technical discussion	Adequate examples	Few examples
4.	Technical Report Preparation	20	Professional report with proper references and formatting	Good report	Incomplete report
5.	Seminar Presentation & Interaction	20	Excellent presentation, confidence, and response to questions	Good presentation	Poor communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12			12	2
C02	24	24			24	2
C03	24	24			24	2
C04			40		20	3
C05				40	20	3
Total	60	60	40	40	100	

Note: Strength = 3 (if percentage >20%); Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%).

26WT104	METALLOGRAPHY LABORATORY			SEMESTER		I	
Prerequisites			Category	ES(PC)	Credits		2
Engineering Materials and Metallurgy			Hours/ Semester	L	T	P	TH
				0	0	60	60
COURSE OBJECTIVES							
1.	To develop skills in metallographic specimen preparation and microscopic examination techniques.						
2.	To study the microstructures of ferrous, non-ferrous and heat-treated materials.						
3.	To understand grain structure, phase transformations and weld microstructures.						
4.	To analyze metallurgical characteristics using microscopy and image analysis techniques.						
5.	To evaluate material behavior and engineering performance through metallographic investigations.						
List of Experiments							
1.	Study of Metallurgical Microscope and Specimen Preparation						
2.	Macro Examination of Engineering Materials						
3.	Microstructure of Carbon Steels						
4.	Microstructure of Cast Irons (Unetched Condition)						
5.	Microstructure of Cast Irons (Etched Condition)						
6.	Microstructure of Non-Ferrous Alloys						
7.	Microstructure of Annealed and Normalized Steels						
8.	Microstructure of Hardened steels						
9.	Grain Size Measurement						
10.	Microstructure of Weldments						
Total: 60 Hours							
Weightage: Continuous Assessment 60% End Semester Examinations 40%							
REFERENCE BOOKS:							
1.	ASM Handbook, Volume 9, Metallography and Microstructures, ASM International, The Materials Information Company, 2004.						
2.	George F. Vander Voort, Metallography: Principles and Practice, ASM International, 1999.						
E-RESOURCES:							
1.	ASM International – ASM Handbooks Online ASM International						
2.	ASTM International – Metallographic Standards ASTM International						
3.	Metallography.org – Sample Preparation and Metallography Resources Metallography.org						

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Perform metallographic specimen preparation, polishing, etching and microscopic examination of engineering materials and weldments.	–	–
CO2	Characterize the microstructures of ferrous, non-ferrous and heat-treated materials using metallographic testing techniques.	PO1	PSO1
CO3	Analyze grain structure, phase transformations and microstructural features of engineering materials through metallographic investigations.	PO1	PSO1, PSO2
CO4	Evaluate weld microstructures, weld bead characteristics and hardness distribution in similar and dissimilar weldments.	PO2, PO3	PSO1, PSO2
CO5	Interpret metallographic observations, prepare technical reports and recommend suitable materials or welding conditions for engineering applications.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	3	-	-	3	-
CO3	3	-	-	3	2
CO4	-	3	3	3	2
CO5	3	3	3	3	3
Average	3.0	3.0	3.0	3.0	2.33

Activities:

CO4 Activities

Activity 1

Microstructural Evaluation of Similar and Dissimilar Weldments

Activity 2

Hardness Mapping and Weld Bead Characterization of Welded Joints

CO5 Activities

Activity 1

Grain Size Measurement and Material Characterization using ASTM Standards

Activity 2

Failure Analysis and Technical Metallographic Investigation Report

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content
2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization

3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information
5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Grain Size / Failure Analysis Problem Definition	20	Clearly defined investigation	Minor gaps	Unclear definition
2.	Experimental Methodology	20	Appropriate and comprehensive methodology	Adequate methodology	Limited methodology
3.	Metallographic Analysis	20	Thorough and technically correct analysis	Moderate analysis	Limited analysis
4.	Material Selection / Technical Justification	20	Strong justification using metallographic evidence	Partial justification	Weak justification
5.	Report Preparation & Documentation	20	Professional report and documentation	Adequate report	Incomplete report
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Laboratory component		Percentage allocation	Mapping Strength
	Observation and Record	Activities		
C01	20	20	20	2
C02	20	20	20	2
C03	20	20	20	2
C04	20	20	20	2
C05	20	20	20	2
Total	100	100	100	

Note: Purely as anExample: Strength = 3 (if percentage >20%);
Strength =2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26WT105	JOINING LABORATORY			SEMESTER		I	
Prerequisites			Category	ES(PC)	Credits	2	
Engineering Material and Metallurgy			Hours/ Semester	L	T	P	TH
				0	0	60	60
COURSE OBJECTIVES							
1.	To understand the principles, equipment and safety practices involved in various welding and joining processes.						
2.	To develop practical skills in conventional and advanced welding techniques used in manufacturing industries.						
3.	To study the influence of welding parameters on weld quality and performance.						
4.	To analyze weld characteristics, weldability and defects in engineering materials.						
5.	To evaluate suitable joining processes for industrial applications and quality assurance.						
List of Experiments							
1.	Study and Demo of Welding Machines						
2.	Arc – Striking and Weld Bead Practices by SMAW process						
3.	Preparation of joints by SMAW process						
4.	Weld Bead Practices by GTAW process						
5.	Weld Bead Practices by GMAW process						
6.	Friction welding of metals						
7.	Friction Stir welding of metals						
8.	Ultrasonic welding of metals and plastics						
9.	Weldability test for Hot cracking and Cold cracking						
10.	Preparation practices for WPS and PQR						
Total:60 Hours							
Weightage: Continuous Assessment 60% End Semester Examinations 40%							
REFERENCE BOOKS:							
1.	S. E. Cary and Scott C. Helzer, Modern Welding Technology, 6th Edition, Pearson Education.						
2.	J. F. Lancaster, Metallurgy of Welding, 6th Edition, Abington Publishing.						
3.	J. Norrish, Advanced Welding Processes: Technologies and Process Control, Woodhead Publishing.						
E-RESOURCES:							
1.	American Welding Society – www.aws.org						
2.	TWI – The Welding Institute – www.twi-global.com						
3.	NPTEL – nptel.ac.in						
4.	Lincoln Electric – Welding Resources						

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Perform safe welding practices and operate conventional and advanced welding equipment used in joining processes.	–	–
CO2	Produce sound welded joints using SMAW, GTAW, GMAW and advanced joining processes by selecting appropriate process parameters.	PO1	PSO1
CO3	Analyze the influence of welding parameters on weld bead geometry, weld quality and joint performance.	PO1	PSO1, PSO2
CO4	Evaluate weld characteristics, weld defects and weldability of engineering materials through experimental investigations.	PO2, PO3	PSO1, PSO2
CO5	Assess the quality and suitability of welded joints and recommend appropriate joining processes for industrial applications based on experimental results.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	3	-	-	3	-
CO3	3	-	-	3	2
CO4	-	3	3	3	2
CO5	3	3	3	3	3
Average	3.0	3.0	3.0	3.0	2.33

Activities: CO4, CO5

CO4 Activities

Activity 1

Evaluation of Weld Quality using Destructive and Non-Destructive Testing Methods

Activity 2

Assessment of Weldability and Joint Performance in Different Welding Processes

(Based on Experiments 6, 7, 8 and 10)

CO5 Activities

Activity 1

Selection of Suitable Welding Process for Industrial Applications

Activity 2

Preparation of Technical Report on Weld Quality and Process Optimization

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content
2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization

3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information
5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Problem Definition and Process Selection	20	Appropriate process selected with strong justification	Adequate selection	Poor selection
2.	Experimental Analysis	20	Comprehensive analysis of welding results	Moderate analysis	Limited analysis
3.	Technical Recommendations	20	Recommendations fully supported by experimental evidence	Partial justification	Weak justification
4.	Process Optimization Strategy	20	Effective optimization approach proposed	Moderate optimization	Limited optimization
5.	Technical Report and Documentation	20	Professional report with clear conclusions	Adequate report	Poor documentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Laboratory component		Percentage allocation	Mapping Strength
	Observation and Record	Activities		
CO1	20	20	20	2
CO2	20	20	20	2
CO3	20	20	20	2
CO4	20	20	20	2
CO5	20	20	20	2
Total	100	100	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26WT106		TECHNICAL SEMINAR		SEMESTER		I	
Prerequisites			Category	SD	Credits		1
			Hours/ Semester	L	T	P	TH
				0	0	30	30
COURSE OBJECTIVES							
1.	To work on a specific technical topic in Engineering design related topics to acquire the skills of oral presentation						
2.	To acquire technical writing abilities for seminars and conferences.						
3.	To identify and compare technical and practical issues related to the area of course specialization.						
4.	To outline annotated bibliography of research demonstrating scholarly skills						
5.	Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presenting						
MODULES							
1.	The students will work for two hours per week guided by a group of staff members.						
2.	They will be asked to talk on any topic of their choice related to Engineering design, and search relevant journal paper/white paper on the selected topics for presentation and to engage in dialogue with the audience.						
3.	A brief copy of their talk also should be submitted.						
4.	Similarly, the students will have to present a seminar of not less than fifteen minutes and not more than thirty minutes on the technical topic along with the journal reference copy.						
5.	They will also answer the queries on the topic. The students as the audience also should interact.						
6.	Evaluation will be based on the technical presentation and their port and also on the interaction during the seminar using the specific rubrics.						
Total=30 Periods							
Weightage:							
Continuous Assessment:100%							
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs	Mapping PSOs		
CO1	Explain the selected engineering design topic and its technical background using appropriate literature sources						
CO2	Collect, review, and summarize technical information from journals, conference papers, and industry reports.			PO1	PSO2		
CO3	Analyze and compare technical approaches, practical issues, and recent developments related to the selected topic.			PO1	PSO2		
CO4	Evaluate research findings, identify gaps, and respond to technical queries during seminar discussions.			PO2, PO3	PSO1		
CO5	Prepare and deliver a professional technical seminar report and presentation demonstrating communication, documentation, and scholarly skills.			PO1, PO2, PO3	PSO1, PSO2		

The Course Articulation Matrix (CAM) for defined COs						
COs / POs		PO1	PO2	PO3	PSO1	PSO2
CO1		2	1		1	1
CO2		3			1	2
CO3		3	2		2	2
CO4			3	2	2	
CO5		3	3	3	2	2
Average		2.75	2.25	2.50	1.60	1.75
Activities:						
1.	Literature Review and Annotated Bibliography					
2.	Technical Seminar Presentation and Discussion					
Rubrics for evaluation: 1						
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)	
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content	
2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization	
3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis	
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information	
5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication	
	Total	100				
Rubrics for evaluation: 2						
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)	
1.	Technical Content and Accuracy	20	Highly accurate and in-depth	Generally accurate	Superficial content	
2.	Organization and Clarity	20	Excellent flow and clarity	Adequate organization	Poor organization	

3.	Presentation Skills	20	Confident, engaging, professional delivery	Adequate delivery	Weak delivery
4.	Response to Questions	20	Accurate and insightful responses	Adequate responses	Unable to answer satisfactorily
5.	Report Quality and Referencing	20	Well-structured report with proper references	Adequate report	Poor documentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Component		Percentage allocation	Mapping Strength
	Review 1	Review 2		
CO1	10	0	10	2
CO2	15	5	20	2
CO3	15	5	20	2
CO4	10	15	25	3
CO5	10	15	25	3
Total	60	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);

Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26WT201	JOINING PROCESSES – II			SEMESTER		II	
Prerequisites			Category	ES(PC)	Credits	3	
Manufacturing Technology			Hours/ Semester	L	T	P	TH
				45	0	0	45
COURSE OBJECTIVES							
1.	To understand the various special/ advanced welding processes.						
2.	To gain knowledge on the principle of operation, advantages, limitations and applications of various special/ advanced welding processes.						
UNIT - I		ELECTRON BEAM WELDING (EBW) AND LASER BEAM WELDING (LBW)					9
Heat generation and regulation, equipment details, process variables, electron beam welding in different degrees of vacuum. Advantages, limitations and applications. Laser Beam Welding: Laser sources for welding, Principles of operation. Advantages, limitations and applications.Introduction to Hybrid Welding Process.							
UNIT - II		ELECTRO SLAG WELDING AND RESISTANCE WELDING					9
Electro slag welding - Principle of operation, wire and consumable guide techniques, process variables, joint design, properties and functions of fluxes. Advantages, limitations and applications. Electro gas welding - Principle of operation. Resistance welding – Basic Principles. Advantages, limitations and applications. Types – Spot welding, Seam welding, Projection welding, Flash welding, Upset welding, Percussion welding, High frequency welding. Choice of electrode material.							
UNIT - III		SOLID STATE WELDING PROCESSES - I					9
Advantages of solid state welding processes over conventional welding processes. Principle, advantages, limitations and applications of Cold pressure welding, Hot pressure welding Induction pressure welding, Explosive welding, Diffusion welding, Ultrasonic welding, Forge welding and Roll welding processes.							
UNIT - IV		SOLID STATE WELDING PROCESSES - II					9
Friction Welding (FRW) – Principle, Theoretical considerations, Process characteristics, Friction Welding machines and equipments, welding variables, Joint design, Advantages, limitations and applications. Friction Stir Welding (FSW) - Principles of the process, process parameters - tool rotation, traverse speed, tool tilt angle and plunge depth. Tool geometry. Flow of heat and various zones. Advantages, limitations and applications.							
UNIT - V		OTHER JOINING PROCESSES					9
Principle and applications of Thermit welding process. Stud welding (SW) - Equipment, operation, Stud welding gun, Ferrules. Advantages, limitations and applications. Adhesive bonding – Concept, Procedure, Testing of Adhesive bonded joints, types of adhesive bonded joints, Sandwich Construction, selection and types of adhesives.Advantages, limitations and applications of Adhesive bonding. Welding of plastics, Underwater Welding.							
L:45, Total:45 Hours							
Weightage:							
Continuous Assessment 40%							
End Semester Examinations 60%							

REFERENCE BOOKS:					
1.	AWS Welding Handbook, Volume 2: Welding Processes, 9th Edition, American Welding Society, 2013.				
2.	Schwartz M.M., <i>Metals Joining Manual</i> , McGraw-Hill Publications, 1979.				
3.	ASM Handbook, Volume 6: Welding, Brazing and Soldering, 10th Edition, ASM International, 1995.				
4.	Howard B. Cary and Scott Helzer, <i>Modern Welding Technology</i> , 7th Edition, Pearson Education, 2021.				
5.	Christopher Davis, <i>Laser Welding: A Practical Guide</i> , Jaico Publishing House, 1994.				
6.	R.S. Parmar, <i>Welding Processes and Technology</i> , 2nd Edition, Khanna Publishers, 2005.				
7.	ASM Handbook, Volume 6: Welding, Brazing and Soldering, ASM International, 2017.				
8.	ASM Handbook, Volume 6A: Welding Fundamentals and Processes, ASM International, 2017.				
E-RESOURCES:					
1.	NPTEL – Advanced Welding Processes.				
2.	NPTEL – Manufacturing Processes and Technology.				
3.	American Welding Society (AWS) Learning Resources.				
4.	ASM Digital Library – Welding and Joining.				
5.	ScienceDirect – Welding and Joining Research Publications.				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs		
CO1	Explain the principles, equipment, process characteristics, advantages, limitations and applications of advanced and special welding processes including high energy beam, resistance, solid-state and other joining processes.	-	-		
CO2	Apply the operating principles and process parameters of advanced welding and joining processes for suitable engineering and fabrication applications.	PO1	PSO2		
CO3	Analyze the influence of welding variables, joint design, process selection and operating conditions on weld quality and performance in advanced joining processes.	PO1	PSO1		
CO4	Evaluate the suitability of advanced welding and joining processes based on material characteristics, productivity, weld quality, process limitations and industrial application requirements.	PO2, PO3	PSO1, PSO2		
CO5	Recommend appropriate advanced welding and joining processes to fabricate engineering components considering technical feasibility, application requirements and service conditions.	PO1, PO2, PO3	PSO1, PSO2		
The Course Articulation Matrix (CAM) for defined COs					
	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2	3				2
CO3	3			2	
CO4		3	3	2	2
CO5	3	3	3	3	3

Activities:					
1.	Activity I (CO4): Technical Poster Presentation on Advanced Welding and Joining Processes				
2.	Activity II (CO5): Technical Seminar Presentation on Emerging Trends in Advanced Joining Technologies (Independent Study)				
Rubrics for evaluation: CO4					
Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content
2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization
3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information
5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication
	Total	100			
Rubrics for evaluation: CO5					
Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Topic Selection & Literature Review	20	Recent and highly relevant topic with good literature support	Relevant topic	Basic topic
2.	Technical Understanding	20	Demonstrates excellent conceptual understanding	Good understanding	Limited understanding
3.	Industrial Applications / Case Study	20	Well-supported with industrial examples and technical discussion	Adequate examples	Few examples

4.	Technical Report Preparation	20	Professional report with proper references and formatting	Good report	Incomplete report
5.	Seminar Presentation & Interaction	20	Excellent presentation, confidence, and response to questions	Good presentation	Poor communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Strength = 3 (if percentage >20%); Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%).

26WT202	JOINING AND ALLIED PROCESSES			SEMESTER		II	
Prerequisites			Category	ES(PC)	Credits	4	
Manufacturing Technology			Hours/ Semester	L	T	P	TH
				45	15	0	60
COURSE OBJECTIVES							
1.	Explain the concepts of brazing and soldering.						
2.	Identify suitable fluxes, atmosphere and filler metals used for brazing and soldering.						
3.	Identify different type of brazing and soldering for various applications.						
4.	Explain different types of surfacing techniques.						
5.	Discuss the various thermal cutting processes.						
UNIT – I		FUNDAMENTALS OF BRAZING AND SOLDERING					9+6
Wetting and spreading characteristics, surface tension and contact angle concepts. Filling of horizontal and vertical capillary joints. Capillary dams. Fundamentals of brazed and soldered joints, advantages, limitations and applications of brazing and soldering.							
UNIT - II		FLUXES AND ATMOSPHERES FOR BRAZING AND SOLDERING					9+6
Role of flux and characteristics, constituents of flux, grouping and applications, fluxes used for specific braze metals, flux removal and related corrosion problems. Atmospheres for brazing and atmosphere selection for specific base metals. Metallurgy of filler metals for brazing and soldering. Joint design and fixturing for brazing.							
UNIT - III		SOLDERING AND BRAZING PROCESSES					9+6
Hand soldering, flame soldering, furnace soldering, hot gas blanket soldering, wave soldering and related applications. Torch brazing, furnace brazing, induction brazing, dip brazing, resistance brazing, vacuum brazing and related applications. Brazing and soldering defects, causes and remedial measures.							
UNIT - IV		SURFACING					9+6
Thermal spraying, plasma spraying, laser surface alloying and modification. Surfacing techniques for improving wear resistance and corrosion resistance. Chemical Vapour Deposition (CVD), Physical Vapour Deposition (PVD) and ion implantation. Cladding processes and industrial applications.							
UNIT – V		THERMAL CUTTING PROCESSES					9+6
Oxygen cutting – oxyfuel gas cutting, metal powder cutting, chemical flux cutting and oxygen arc cutting. Arc cutting processes – carbon arc cutting, air carbon arc cutting, Arc Gouging, metal arc cutting and plasma arc cutting.High energy beam cutting – Electron beam cutting, Laser beam cutting. Water jet cutting and Underwater cutting.							
L:45+T:15, Total:60 Hours							
Weightage: Continuous Assessment 40% End Semester Examinations 60%							

REFERENCE BOOKS:					
1.	Schwartz M., <i>Brazing: For the Engineering Technologist</i> , Chapman & Hall, 1995.				
2.	Manko H.H., <i>Solders and Soldering</i> , 2nd Edition, McGraw-Hill, 1979.				
3.	Udin H., Funk R.E. and Wulff J., <i>Welding for Engineers</i> , Wiley Publications.				
4.	ASM Handbook, Volume 6: <i>Welding, Brazing and Soldering</i> , ASM International, 2018.				
5.	Brooke R.M., <i>Industrial Brazing</i> , Becton Publishers, 1975.				
6.	Howard B. Cary and Scott Helzer, <i>Modern Welding Technology</i> , 7th Edition, Pearson Education, 2021.				
7.	R.S. Parmar, <i>Welding Processes and Technology</i> , 2nd Edition, Khanna Publishers, 2005.				
E-RESOURCES:					
1.	NPTEL – Welding Technology.				
2.	NPTEL – Surface Engineering and Coating Technologies.				
3.	American Welding Society (AWS) Digital Learning Resources.				
4.	ASM Digital Library – Brazing, Soldering and Surface Engineering.				
5.	ScienceDirect – Joining and Surface Engineering Journals.				
6.	SpringerLink – Surface Modification and Manufacturing Processes.				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs		
CO1	Understand and Explain Understand and recall the fundamental principles, applications, advantages, and limitations of brazing, soldering, surfacing, and cutting.	-	-		
CO2	Apply the concepts of wetting, flux selection, atmosphere control, joint design, surfacing methods, and cutting processes to solve engineering problems.	PO1	PSO2		
CO3	Analyze the behavior of filler metals, joints, process parameters, defects, and surface modification methods, and evaluate suitable brazing, soldering, surfacing, and cutting techniques for specific materials and service conditions.	PO1	PSO1		
CO4	Submit a presentation onthe behaviour of filler metals, joints, process parameters, defects, and surface modification methods to interpret process performance through self-learning activities and present the findings while considering societal and economic impacts.	PO2, PO3	PSO1, PSO2		
CO5	Submit a Process Selection and Design Project for brazing, soldering, surfacing, and cutting techniques for specific materials, service conditions, and component requirements for chosen industrial applications through self-learning activities and present the findings while considering societal and economic impacts.	PO1, PO2, PO3	PSO1, PSO2		
The Course Articulation Matrix (CAM) for defined COs					
	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			2	3	1
CO3	2		1	3	1
CO4	2	3	1	2	3
CO5	3	2	3	3	3

Activities:

1.	Activity I (CO4): Technical Poster Presentation on Brazing, Soldering, Surfacing and Thermal Cutting Processes
2.	Activity II (CO5): Technical Seminar Presentation on Recent Developments in Joining and Surface Engineering Processes (Independent Study)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content
2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization
3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information
5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Topic Selection & Literature Review	20	Recent and highly relevant topic with good literature support	Relevant topic	Basic topic
2.	Technical Understanding	20	Demonstrates excellent conceptual understanding	Good understanding	Limited understanding
3.	Industrial Applications / Case Study	20	Well-supported with industrial examples and technical discussion	Adequate examples	Few examples
4.	Technical Report Preparation	20	Professional report with proper references and formatting	Good report	Incomplete report
5.	Seminar Presentation & Interaction	20	Excellent presentation, confidence, and response to questions	Good presentation	Poor communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Strength = 3 (if percentage >20%); Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%).

26WT203	DESIGN OF WELDMENTS			SEMESTER		II	
Prerequisites			Category	ES(PC)	Credits	3	
Manufacturing Technology			Hours/ Semester	L	T	P	TH
				45	0	0	45
COURSE OBJECTIVES							
1.	To understand the fundamentals of weld joint design and welding symbols used in engineering practice.						
2.	To develop competency in designing welded joints subjected to static loads.						
3.	To understand fatigue behavior and design considerations for dynamically loaded welded structures.						
4.	To study residual stresses, distortion mechanisms and their control methods in welded components.						
5.	To analyze failures in welded structures and develop suitable design solutions for improved performance.						
UNIT – I		DESIGN BASICS					9
Types of joints, types of welds, variants of welded joints, selection of weld type, weld joints for structural tubular connections, welding symbols, weld dimensions and NDT symbols. Principles of weld joint design – general and specific design principles. Design considerations for welded structures and fabrication requirements.							
UNIT - II		WELD DESIGN FOR STATIC LOADING					9
Material and section properties. Weld design stress calculations. Design of welded joints under tensile, compressive, bending, shear, torsional and shock loading conditions. Design examples and engineering applications.							
UNIT - III		WELD DESIGN FOR DYNAMIC LOADING					9
Fundamentals of fatigue and fatigue failure. S-N curves, Goodman diagram, factors affecting fatigue life of welded joints. Methods of improving fatigue strength of welded structures. Design for fatigue loading. Weld design using fracture toughness (K_{Ic}) concepts.							
UNIT - IV		DISTORTION AND RESIDUAL STRESSES					9
Residual stresses in welding – causes, occurrence and effects. Thermal and mechanical stress-relieving methods. Types of distortion, factors affecting distortion, distortion prediction and control methods. Distortion correction methods, jigs, fixtures and welding positioners.							
UNIT - V		FAILURE ANALYSIS IN DESIGN ASPECTS					9
Failure analysis methodology, approaches, tools and techniques. Modes of failure in welded structures. Failure data retrieval and interpretation. Procedural steps in failure investigation. Case studies on failure analysis and design of welded components.							
L:45, Total:45 Hours							
Weightage: Continuous Assessment 40% End Semester Examinations 60%							

REFERENCE BOOKS:					
1.	Omer W. Blodgett, <i>Design of Weldments</i> , James F. Lincoln Arc Welding Foundation, 1991.				
2.	R.S. Parmar, <i>Welding Engineering and Technology</i> , 2nd Edition, Khanna Publishers, 2010.				
3.	T.R. Gurney, <i>Fatigue of Welded Structures</i> , Cambridge University Press, 1980.				
4.	S.T. Rolfe and J.M. Barsom, <i>Fracture and Fatigue Control in Structures: Applications of Fracture Mechanics</i> , 3rd Edition, ASTM International, 1999.				
5.	ASM Handbook, Volume 11: <i>Failure Analysis and Prevention</i> , ASM International, 2002.				
6.	A.K. Das, <i>Metallurgy of Failure Analysis</i> , Tata McGraw-Hill, 1997.				
7.	Donald J. Wulpi, <i>Understanding How Components Fail</i> , 3rd Edition, ASM International, 2013.				
8.	V.J. Colangelo and F.A. Heiser, <i>Analysis of Metallurgical Failures</i> , 2nd Edition, Wiley-Interscience, 1987.				
E-RESOURCES:					
1.	NPTEL – Strength of Materials and Structural Design.				
2.	American Welding Society (AWS) Design Resources.				
3.	ASM International Digital Library.				
4.	TWI Knowledge Hub – Weld Design and Failure Analysis.				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs		
CO1	Explain weld joint configurations, welding symbols, design principles and failure mechanisms in welded structures.				
CO2	Apply weld design procedures for components subjected to static loading conditions.	PO1	PSO2		
CO3	Analyze fatigue behavior, fracture mechanics concepts and dynamic loading effects on welded structures.	PO1	PSO1		
CO4	Evaluate residual stresses, distortion effects and failure modes in welded components using engineering design principles.	PO2, PO3	PSO1, PSO2		
CO5	Develop safe and reliable weld designs by integrating loading conditions, fatigue considerations, distortion control and failure analysis techniques.	PO1, PO2, PO3	PSO1, PSO2		
The Course Articulation Matrix (CAM) for defined Cos					
	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			2		1
CO3	2		1	1	1
CO4	2	3	1		2
CO5	3	2	3	2	2

Activities:

1.	Activity I: Technical Poster Presentation on Weld Joint Design and Failure Prevention (CO4)
2.	Technical Seminar on Industrial Design of Welded Structures (CO5) (Independent Study)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content
2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization
3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information
5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Topic Selection & Literature Review	20	Recent and highly relevant topic with good literature support	Relevant topic	Basic topic
2.	Technical Understanding	20	Demonstrates excellent conceptual understanding	Good understanding	Limited understanding
3.	Industrial Applications / Case Study	20	Well-supported with industrial examples and technical discussion	Adequate examples	Few examples

4.	Technical Report Preparation	20	Professional report with proper references and formatting	Good report	Incomplete report
5.	Seminar Presentation & Interaction	20	Excellent presentation, confidence, and response to questions	Good presentation	Poor communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Strength = 3 (if percentage >20%); Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%).

26WT204	QUALITY CONTROL OF WELDMENTS LABORATORY		SEMESTER			II
Prerequisites		Category	ES(PC)	Credits		2
Engineering Material and Metallurgy		Hours/ Semester	L	T	P	TH
			0	0	60	60
COURSE OBJECTIVES						
1.	Explain the practical aspects of welding gauges and their applications.					
2.	Hands on experience in material testing and their sample preparation.					
3.	Exposure of various quality control tests.					
4.	Understand and report welding documents (WPS, PQR &WPQ).					
List of Experiments						
1.	Study of Welding Gauges					
2.	Tensile test of weldments					
3.	Bend test of weldments					
4.	Hardness survey of weldments					
5.	Impact test of weldments					
6.	Visual Inspection					
7.	Dye-Penetrant Testing					
8.	Magnetic Particle Testing					
9.	Ultrasonic Testing					
10.	Radiographic Film Interpretation					
Total:60 Hours						
Weightage: Continuous Assessment 60% End Semester Examinations 40%						
REFERENCE BOOKS:						
1.	R. Halmshaw, Introduction to Non-Destructive Testing, 2nd Edition, Edward Arnold.					
2.	J. C. Hellier, Handbook of Nondestructive Evaluation, 2nd Edition, McGraw-Hill.					
3.	Paul E. Mix, Introduction to Nondestructive Testing: A Training Guide, 2nd Edition, Wiley.					
E-RESOURCES:						
1.	American Welding Society – www.aws.org					
2.	ASME – ASME Codes and Standards					
3.	TWI – The Welding Institute – www.twi-global.com					
4.	NPTEL – www.nptel.ac.in					
5.	BINDT – British Institute of Non-Destructive Testing					
6.	ASTM International – www.astm.org					
7.	ISO – www.iso.org					

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Perform welding measurement, inspection and quality control practices using welding gauges and measuring instruments.	PO3	PSO1
CO2	Conduct destructive testing experiments on weldments and interpret the mechanical performance of welded joints.	PO1, PO3	PSO1
CO3	Carry out non-destructive testing procedures to identify and evaluate weld discontinuities and defects.	PO1, PO3	PSO1
CO4	Prepare and validate welding quality documents such as WPS, PQR and WPQ for industrial welding applications.	PO2, PO3	PSO2
CO5	Evaluate weld quality through testing and inspection results and recommend suitable corrective measures for quality improvement.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

CO / PO	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	3	3	-
CO2	3	-	3	3	-
CO3	3	-	3	3	-
CO4	-	3	3	-	3
CO5	3	3	3	3	3

Activities: CO4, CO5

CO4 Activities

Experimental Evaluation of Weld Quality using Mechanical Testing and Inspection Results

Activity 1

Assessment of Weld Defects and Structural Integrity of Weldments using Destructive and Non-Destructive Testing Techniques

CO5 Activities

Preparation and Verification of Welding Procedure Specification (WPS)

Activity 2

Evaluation of PQR and Welder Qualification Records (WPQ)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content
2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization
3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information

5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Problem Identification and Objective Definition	20	Clearly identifies the engineering problem and objectives	Minor gaps in problem definition	Problem not clearly defined
2.	Experimental Methodology and Execution	20	Appropriate methodology selected and executed systematically	Adequate methodology with minor errors	Limited or incorrect methodology
3.	Technical Analysis and Interpretation	20	Comprehensive analysis and interpretation of results	Moderate analysis and interpretation	Limited analysis
4.	Evaluation and Technical Justification	20	Conclusions supported with strong technical justification	Partial justification	Weak justification
5.	Report Preparation and Presentation	20	Professional report with clear presentation and documentation	Adequate report and presentation	Poor documentation and presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Laboratory component		Percentage allocation	Mapping Strength
	Observation and Record	Activities		
CO1	20	20	20	2
CO2	20	20	20	2
CO3	20	20	20	2
CO4	20	20	20	2
CO5	20	20	20	2
Total	100	100	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26WT205	MATERIALS CHARACTERIZATION LABORATORY		SEMESTER			II
Prerequisites		Category	ES(PC)	Credits		2
Engineering Material and Metallurgy		Hours/ Semester	L	T	P	TH
			0	0	60	60
COURSE OBJECTIVES						
1.	To understand the principles and applications of advanced material characterization techniques.					
2.	To develop practical skills in crystallographic, microstructural, thermal, and corrosion characterization methods.					
3.	To analyze and interpret characterization data obtained from various material testing techniques.					
4.	To evaluate material properties and performance using experimental characterization results.					
5.	To develop technical reporting and problem-solving skills for materials research and engineering applications.					
List of Experiments						
1.	Determination of grain size and volume fraction of phases using image analysis.					
2.	Determination of nodularity and nodule count in cast iron using image analysis.					
3.	Marking of Poles and Planes by Stereographic projection.					
4.	Indexing of XRD patterns.					
5.	Estimation of precise lattice parameter for cubic crystals.					
6.	Determination of crystallite size and r.m.s. strain for mechanically alloyed powder.					
7.	Analysis of SEM fractographs.					
8.	Analysis of TEM images of metals and alloys.					
9.	Interpretation of Thermal analysis curves.					
10.	Corrosion rate determination by a) weight loss method, b) effect of inhibitor.					
Total:60 Hours						
Weightage: Continuous Assessment 60% End Semester Examinations 40%						
REFERENCE BOOKS:						
1.	B. D. Cullity and S. R. Stock, Elements of X-Ray Diffraction, 3rd Edition, Prentice Hall, 2001.					
2.	D. B. Williams and C. B. Carter, Transmission Electron Microscopy: A Textbook for Materials Science, 2nd Edition, Springer, 2009.					
E-RESOURCES:						
1.	MIT OpenCourseWare – Materials Science Resources					
2.	International Union of Crystallography					
3.	International Centre for Diffraction Data					
4.	National Institute of Standards and Technology					
5.	University of Cambridge – DoITPoMS					
6.	JEOL – Electron Microscopy Resources					

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Perform crystallographic, microstructural, thermal and corrosion characterization experiments using advanced characterization techniques.	PO3	PSO1
CO2	Analyze crystal structures, lattice parameters, crystallite size and phase constituents using XRD characterization methods.	PO1	PSO1
CO3	Interpret SEM, TEM, thermal analysis and image analysis results to investigate microstructural features and material behaviour.	PO1	PSO1, PSO2
CO4	Evaluate material properties, phase transformations and corrosion performance through characterization data and experimental observations.	PO2, PO3	PSO1, PSO2
CO5	Assess material characteristics and prepare technical reports with suitable engineering recommendations based on characterization results.	PO1, PO2, PO3	PSO1, PSO2
CO6	Perform crystallographic, microstructural, thermal and corrosion characterization experiments using advanced characterization techniques.	PO3	PSO1

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	3	3	-
CO2	3	-	-	3	-
CO3	3	-	-	3	2
CO4	-	3	3	3	2
CO5	3	3	3	3	3
Average	3.0	3.0	3.0	3.0	2.33

Activities: CO4, CO5

CO4 Activities

Activity 1

Evaluation of Material Properties using Thermal Analysis and Image Analysis Techniques

Activity 2

Assessment of Corrosion Behaviour of Engineering Materials

CO5 Activities

Activity 1

Material Selection and Application Recommendation Based on Characterization Results

Activity 2

Technical Report Preparation and Presentation on Material Characterization Case Study

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content

2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization
3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information
5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Problem Formulation and Objectives	20	Problem and objectives clearly formulated	Minor gaps in formulation	Unclear formulation
2.	Solution Development / Recommendation	30	Appropriate and technically sound recommendations	Adequate recommendations	Limited recommendations
3.	Technical Justification	20	Recommendations supported by characterization results	Partial justification	Weak justification
4.	Report Presentation and Documentation	20	Professional presentation and documentation	Adequate presentation	Poor presentation
5.	Communication of Findings	10	Findings communicated clearly and effectively	Minor communication issues	Poor communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Laboratory component		Percentage allocation	Mapping Strength
	Observation and Record	Activities		
CO1	20	20	20	2
CO2	20	20	20	2
CO3	20	20	20	2
CO4	20	20	20	2
CO5	20	20	20	2
Total	100	100	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26WT301		DISSERTATION PHASE - I		SEMESTER		III	
Prerequisites			Category	SD	Credits		8
			Hours/ Semester	L	T	P	TH
				0	0	240	240
COURSE OBJECTIVES							
1.	To develop the ability to solve a specific problem right from its identification and literature review until the successful solution of the same.						
2.	To train the students in preparing project reports and to face reviews and viva voce examination						
CONTENTS							
1.	The Project Work will start in semester III and should preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.						
2.	The seminar should be based on the area in which the candidate has undertaken the dissertation work as per the common instructions for all branches of M. E.						
3.	The examination shall consist of the preparation of a report consisting of a detailed problem statement and a literature review.						
4.	The preliminary results (if available) of the problem may also be discussed in the report. The work has to be presented in front of the examiner's panel set by Head and PG coordinator						
5.	The candidate has to be in regular contact with his guide and the topic of the dissertation must be mutually decided by the guide and student.						
Total =240 Hours							
Weightage: Continuous Assessment 60% End Semester Examinations 40%							
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs		Mapping PSOs	
CO1	Explain the research problem, background, objectives, and relevant engineering concepts through comprehensive literature review.						
CO2	Apply research methodologies, analytical tools, and engineering principles for problem formulation and investigation.			PO1		PSO2	
CO3	Analyze existing literature, identify research gaps, and formulate appropriate approaches to solve engineering problems.			PO1		PSO1, PSO2	
CO4	Evaluate alternative methodologies, technical feasibility, and preliminary results for addressing the identified research problem.			PO2, PO3		PSO1	
CO5	Develop a structured dissertation proposal including problem statement, objectives, methodology, work plan, and preliminary findings.			PO1, PO2, PO3		PSO1, PSO2	

The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
C01					
C02	3				3
C03	3			2	2
C04		3	3	3	
C05	3	3	3	3	2
Average	3.0	3.0	3.0	2.67	2.33
Activities:					
1.	Research Gap Identification and Literature Survey				
2.	Dissertation Proposal Development				
Rubrics for evaluation: 1					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem identification and relevance	20	Clearly defined, novel, and significant research problem	Relevant problem with minor limitations	Basic problem formulation
2.	Literature survey quality	20	Extensive review of high-quality journals and recent literature	Adequate literature review	Limited literature survey
3.	Research gap identification	20	Clearly identifies research gaps and opportunities	Reasonable gap identification	Limited gap analysis
4.	Technical understanding	20	Excellent understanding of the domain and concepts	Good understanding	Basic understanding
5.	Review presentation and communication	20	Excellent presentation and discussion skills	Good communication	Limited communication
	Total	100			
Rubrics for evaluation: 2					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Research objectives and scope	20	Well-defined and achievable objectives	Adequately defined objectives	Objectives lack clarity
2.	Methodology selection	20	Appropriate and technically sound methodology	Adequate methodology	Limited methodology justification

3.	Feasibility and resource planning	20	Comprehensive feasibility assessment	Moderate feasibility study	Basic planning
4.	Preliminary investigation/results	20	Meaningful preliminary work and analysis	Partial investigation completed	Minimal progress
5.	Review presentation and technical discussion	20	Excellent presentation and response to queries	Good presentation	Limited discussion
	Total	100			

Rubrics for evaluation: 3

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Dissertation proposal quality	20	Comprehensive and professionally prepared proposal	Good proposal structure	Basic proposal
2.	Technical progress achieved	20	Significant progress with validated outcomes	Moderate progress	Limited progress
3.	Analysis and interpretation	20	Strong analytical approach and interpretation	Adequate analysis	Basic analysis
4.	Work plan and future scope	20	Realistic and well-defined execution plan	Adequate planning	Limited planning
5.	Presentation, report and viva voce	20	Excellent communication and defense of work	Good presentation	Basic presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Component			Percentage allocation	Mapping Strength
	Review 1	Review 2	Review 3		
CO1	40			10	2
CO2	30	10		20	2
CO3	20	30		20	2
CO4	10	40	20	25	3
CO5		20	80	252	3
Total	100	100	100	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26WT401		DISSERTATION PHASE - II		SEMESTER		IV	
Prerequisites			Category	SD	Credits		14
			Hours/ Semester	L	T	P	TH
				0	0	420	420
COURSE OBJECTIVES							
1.	To develop the ability to solve a specific problem right from its identification and literature review until the successful solution of the same.						
2.	To train the students in preparing project reports and to face reviews and viva voce examination.						
CONTENTS							
1.	The Project Work shall commence in Semester III and should preferably address a problem with research potential involving scientific research, design, data generation/collection, analysis, and solution development, bringing out the individual contribution of the candidate.						
2.	The seminar presentation shall be based on the area of the proposed dissertation work as per the common instructions applicable to all M.E. programmes.						
3.	The examination shall consist of Preparation of a report containing the detailed problem statement, Objectives, Literature review, Proposed methodology, and Preliminary work/results.(if available).						
4.	The preliminary results (if available) of the problem may also be discussed in the report. The work has to be presented in front of the examiner's panel set by Head and PG coordinator						
5.	The candidate has to be in regular contact with his guide and the topic of the dissertation must be mutually decided by the guide and student.						
Total = 420 Hours							
Weightage: Continuous Assessment 60% End Semester Examinations 40%							
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs	Mapping PSOs		
CO1	Explain the research problem, methodology, experimental procedures, and technical concepts related to the dissertation work						
CO2	Apply advanced engineering principles, computational tools, experimental techniques, and research methodologies to solve the identified problem.			PO1	PSO2		
CO3	Analyze experimental, simulation, or analytical results and interpret findings to validate the proposed research objectives.			PO1	PSO1, PSO2		
CO4	Evaluate the effectiveness, feasibility, and significance of the developed solution through validation, comparison, and performance assessment.			PO2, PO3	PSO1		
CO5	Develop and successfully demonstrate an innovative engineering solution, dissertation report, technical publication, and research presentation.			PO1, PO2, PO3	PSO1, PSO2		

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2	3				3
CO3	3			2	2
CO4		3	3	3	
CO5	3	3	3	3	2
Average	3.0	3.0	3.0	2.67	2.33

Activities:

1. Research Paper Preparation and Publication Review
2. Prototype / Simulation Demonstration and Thesis Preparation

Rubrics for evaluation: 1

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Progress against proposed objectives	20	Significant progress achieved as per plan	Moderate progress	Limited progress
2.	Methodology implementation	20	Effective implementation with technical rigor	Adequate implementation	Partial implementation
3.	Technical competence	20	Strong understanding and execution capability	Good understanding	Basic understanding
4.	Documentation of work	20	Well-maintained records and technical documentation	Adequate documentation	Limited documentation
5.	Review presentation and discussion	20	Excellent presentation and response to queries	Good presentation	Basic presentation
	Total	100			

Rubrics for evaluation: 2

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Experimental / Simulation results	20	Comprehensive and reliable results obtained	Adequate results	Limited results
2.	Analysis and interpretation	20	Strong analytical interpretation and insight	Moderate analysis	Basic analysis

3.	Validation and comparison	20	Thorough validation with literature/theory/experiments	Adequate validation	Limited validation
4.	Novelty and technical contribution	20	Significant research contribution and originality	Moderate contribution	Limited novelty
5.	Review presentation and technical defense	20	Excellent technical defense and communication	Good communication	Basic communication
	Total	100			

Rubrics for evaluation: 3

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Achievement of objectives and outcomes	20	All objectives successfully achieved and validated	Most objectives achieved	Partial achievement
2.	Quality of dissertation report	20	Professional, publication-quality dissertation	Good report quality	Basic report quality
3.	Innovation and engineering contribution	20	Significant contribution with strong originality	Moderate contribution	Limited contribution
4.	Results, conclusions and future scope	20	Comprehensive conclusions and meaningful future work	Adequate conclusions	Limited conclusions
5.	Final presentation and viva voice	20	Excellent presentation, confidence, and technical defense	Good presentation	Basic presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Component			Percentage allocation	Mapping Strength
	Review 1	Review 2	Review 3		
CO1	40			10	2
CO2	30	10		20	2
CO3	20	30		20	2
CO4	10	40	20	25	3
CO5		20	80	252	3
Total	100	100	100	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

[illegible]

UNIT - V		ULTRASONIC TESTING AND NDT STANDARDS		9
Ultrasonic waves, wave propagation and characteristics. Inspection methods – pulse echo, transmission and resonance techniques. Scanning methods. Test blocks and IIW reference blocks. Introduction to Time of Flight Diffraction (TOFD) and Phased Array Ultrasonic Testing (PAUT). API codes for pipelines, refinery equipment and storage tanks. ASME Boiler and Pressure Vessel Codes (Sections II, V, VIII and IX). ASME pressure piping codes. Welding Procedure Specification (WPS), Procedure Qualification Record (PQR) and Welder Performance Qualification (WPQ).				
L:45, Total:45 Hours				
Weightage: Continuous Assessment 40% End Semester Examinations 60%				
REFERENCE BOOKS:				
1.	Dieter G.E., <i>Mechanical Metallurgy</i> , SI Metric Edition, McGraw-Hill, 1988.			
2.	Baldev Raj, T. Jayakumar and M. Thavasimuthu, <i>Practical Non-Destructive Testing</i> , Narosa Publishing House, 2002.			
3.	AWS Welding Handbook, Volume 5: <i>Engineering Costs, Quality and Safety</i> , 7th Edition, AWS, 1997.			
4.	Hull B., <i>Non-Destructive Testing</i> , ELBS Edition, 1991.			
5.	McGonnagle W.J., <i>Non-Destructive Testing</i> , 2nd Edition, Gordon and Breach, 1971.			
6.	ASM Handbook, Volume 17: <i>Nondestructive Evaluation and Quality Control</i> , ASM International, 2018.			
7.	ASNT Nondestructive Testing Handbook, Third Edition, American Society for Nondestructive Testing, 2015.			
8.	R. Halmshaw, <i>Non-Destructive Testing</i> , 2nd Edition, Edward Arnold Publishers, 1991.			
9.	Dr.C.Mani, Science and Technology of Nondestructive Examination (NDE), Vol.I, Industrial Radiography, Hawk Press, New Delhi, 2026.			
E-RESOURCES:				
1.	NPTEL – Non-Destructive Evaluation of Materials.			
2.	NPTEL – Mechanical Behaviour of Materials.			
3.	American Society for Nondestructive Testing (ASNT) Learning Resources.			
4.	American Welding Society (AWS) Technical Library.			
5.	ASM International Digital Library.			
6.	TWI Training Resources on NDT and Inspection.			
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to			Mapping POs	Mapping PSOs
CO1	Explain the principles, procedures and applications of destructive and non-destructive testing methods used for weld inspection.			
CO2	Apply tensile, hardness and impact testing methods to evaluate the mechanical performance of weldments.			PO1 PSO2
CO3	Analyze weld discontinuities and defects using liquid penetrant, magnetic particle, eddy current, radiographic and ultrasonic testing techniques.			PO1 PSO1

CO4	Evaluate weld quality and integrity by selecting appropriate testing and inspection methods based on industrial requirements and standards.	PO2, PO3	PSO1, PSO2
CO5	Develop inspection plans and quality assurance procedures using NDT techniques, codes, standards and qualification requirements.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined Cos

	PO1	PO2	PO3	PSO1	PSO2
CO1			2	2	1
CO2	3		1	3	2
CO3	2	3	1	1	3
CO4	3	2	3	2	3
CO5			2	2	1

Activities:

1.	Activity I (CO4): Technical Poster Presentation on Non-Destructive Testing and Weld Inspection Techniques
2.	Activity II (CO5): Technical Seminar Presentation on Advanced Weld Inspection and Quality Assurance (Independent Study)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content
2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization
3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information
5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Topic Selection & Literature Review	20	Recent and highly relevant topic with good literature support	Relevant topic	Basic topic

2.	Technical Understanding	20	Demonstrates excellent conceptual understanding	Good understanding	Limited understanding
3.	Industrial Applications / Case Study	20	Well-supported with industrial examples and technical discussion	Adequate examples	Few examples
4.	Technical Report Preparation	20	Professional report with proper references and formatting	Good report	Incomplete report
5.	Seminar Presentation & Interaction	20	Excellent presentation, confidence, and response to questions	Good presentation	Poor communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Strength = 3 (if percentage >20%); Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%).

26WTE02	ELECTRICAL ASPECTS OF WELDING		SEMESTER		II	
Prerequisites		Category	ES(PE)	Credits	3	
Manufacturing Technology, Basic Electrical and Electronic Engineering		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To understand the physical phenomena, static and dynamic characteristics of welding arcs and power sources.					
2.	To study the operating principles and characteristics of welding transformers and rotating welding machines.					
3.	To gain knowledge on solid-state welding power sources and electronic power regulation techniques.					
4.	To understand automation, monitoring and control techniques employed in modern welding systems.					
5.	To study electrical measurements, sensing techniques and advanced welding power sources used in welding industries.					
UNIT – I		ELECTRICAL CHARACTERISTICS OF WELDING ARC AND POWER SOURCES				9
Physical phenomena occurring in welding arc – potential distribution – static and dynamic arc characteristics – types of forces in arc, arc blow – causes of arc blow, steps to reduce arc blow, methods of arc initiation – methods of arc maintenance – requirements for a welding power source – V-I characteristic of a welding power source – external static V-I characteristic – constant current characteristic – constant voltage characteristic – selection of V-I characteristic for a welding process – dynamic V-I characteristic – simple problems on static V-I characteristics – arc length control.						
UNIT - II		WELDING TRANSFORMERS AND ROTATING MACHINES				9
Requirements of welding transformers – types of welding transformers – high reactance – external reactor – integral reactor – saturable reactor and their characteristics – rotating machines – series generator – separately excited generator – self-excited generator – split pole DC welding generator – output characteristics – multi-operator DC welding generator – duty cycle and simple problems.						
UNIT - III		SOLID STATE WELDING POWER SOURCES				9
Rectification principles – uncontrolled and controlled rectification – basic inverter principles – solid-state electronic power regulation systems – SCR phase control – transistor series regulator – secondary switched transistor (PWM technique) – primary rectification – inverter control – hybrid designs – features of solid-state electronic power source design – advantages of solid-state power sources.						
UNIT - IV		CONTROLS IN ARC WELDING				9
Open loop control and closed loop control – electric wire feed – automatic control techniques – IGBT, MOSFET – monitoring of process – resistance spot welding monitoring and control – seam tracking devices – sensors for seam tracking devices – robotic arc welding system – adaptive control in automated welding system – data acquisition in welding – expert systems in welding.						
UNIT - V		ELECTRICAL MEASUREMENTS IN WELDING AND SPECIAL POWER SOURCES				9
Measurements of welding current, voltage, temperature, load and displacement in welding process – digital storage oscilloscope, LVDT, thermocouples, Hall Effect current sensors, mechanical sensors, LASER detectors, DC shunt, pulsed welding power sources, synergetic welding power sources.						
L:45, Total:45 Hours						

Weightage:

Continuous Assessment 40%

End Semester Examinations 60%

REFERENCE BOOKS:

1.	John Norrish, <i>Advanced Welding Processes</i> , 2nd Edition, Woodhead Publishing, 2006.
2.	R.S. Parmar, <i>Welding Processes and Technology</i> , 2nd Edition, Khanna Publishers, 2005.
3.	Howard B. Cary and Scott Helzer, <i>Modern Welding Technology</i> , 7th Edition, Pearson Education, 2021.
4.	Md. Ibrahim Khan, <i>Welding Science and Technology</i> , New Age International Publishers, 2007.
5.	Pan Jiluan, <i>Arc Welding Control</i> , CRC Press, 2003.
6.	<i>The Procedure Handbook of Arc Welding</i> , 14th Edition, Lincoln Electric, 2000.

E-RESOURCES:

1.	NPTEL – Welding Technology.
2.	NPTEL – Electrical Systems in Manufacturing.
3.	American Welding Society (AWS) Learning Resources.
4.	IEEE Xplore Digital Library – Welding Automation and Control.
5.	ScienceDirect – Welding and Joining Research Publications.

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain welding arc phenomena, welding power source characteristics, welding transformers, solid-state power sources, control systems and electrical measurement techniques used in welding		
CO2	Apply the principles of welding power sources, transformers, rotating machines and solid-state devices for welding operations.	PO1	PSO2
CO3	Analyze arc characteristics, power source performance, welding controls, sensing systems and electrical measurement techniques in welding applications.	PO1	PSO1
CO4	Evaluate welding power source selection, control systems, monitoring techniques and automation strategies for industrial welding processes.	PO2, PO3	PSO1, PSO2
CO5	Develop suitable welding power and control solutions by integrating advanced power sources, sensors and automation techniques for modern welding systems.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined Cos

	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			2		3
CO3	2		1		3
CO4	2	3	1		3
CO5	3	2	3		3

Activities:

1.	Activity I (CO4): Technical Poster Presentation on Welding Power Sources and Arc Control Systems
2.	Activity 2 Technical Seminar Presentation on Modern Welding Power Sources and Automation (Independent Study)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content
2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization
3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information
5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Topic Selection & Literature Review	20	Recent and highly relevant topic with good literature support	Relevant topic	Basic topic
2.	Technical Understanding	20	Demonstrates excellent conceptual understanding	Good understanding	Limited understanding
3.	Industrial Applications / Case Study	20	Well-supported with industrial examples and technical discussion	Adequate examples	Few examples
4.	Technical Report Preparation	20	Professional report with proper references and formatting	Good report	Incomplete report

5.	Seminar Presentation & Interaction	20	Excellent presentation, confidence, and response to questions	Good presentation	Poor communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Strength = 3 (if percentage >20%); Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%).

26WTE03	WELDING APPLICATION TECHNOLOGY		SEMESTER		II	
Prerequisites		Category	ES(PE)	Credits	3	
Manufacturing Technology		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To understand the materials, fabrication practices and welding processes used in structural and pressure vessel applications.					
2.	To study welding technologies employed in storage tanks, piping systems and pipeline industries.					
3.	To understand welding applications in chemical plants, cryogenic systems and micro-joining technologies.					
4.	To acquire knowledge of welding practices used in shipbuilding and railway industries.					
5.	To study materials, fabrication methods and welding technologies employed in aerospace and automobile industries.					
UNIT – I		WELDING OF STRUCTURALS AND PRESSURE VESSELS				9
STRUCTURALS						
Types of structural elements and their welding. Materials used in bridges and welding of bridge structures.						
PRESSURE VESSELS						
Material selection and factors affecting material selection. Fabrication of conventional pressure vessels. Welding processes used in pressure vessel fabrication. Nozzle welding, tube-to-tube plate welds, flanges and vessel ends. Fabrication of clad pressure vessels. Weldability aspects of pressure vessel steels.						
UNIT - II		WELDING OF STORAGE TANKS AND PIPINGS				9
STORAGE TANKS						
Welding of vertical storage tanks and Horton spheres.						
PIPING AND PIPELINES						
Pipe steels and electrodes. Types of joints and welding methods. Backing weld rings and fittings. Alloys used for piping systems. Pipe welding procedures, preheating and post weld heat treatment (PWHT). Offshore pipework, pipelines and pipeline welding. Underwater pipeline welding.						
UNIT - III		WELDING IN CHEMICAL PLANTS, CRYOGENICS AND MICRO JOINING TECHNIQUES				9
CHEMICAL PLANTS						
Welding of oil refinery components and fertilizer plant equipment.						
CRYOGENICS						
Materials used for cryogenic applications. Problems associated with welding cryogenic materials. Welding processes and procedures used for cryogenic materials.						
MICRO JOINING TECHNIQUES						
Techniques used for joining electronic circuits and other micro-joining applications.						
UNIT - IV		WELDING OF SHIP STRUCTURE AND RAILWAYS				9
SHIP STRUCTURE						
Main parts of ship structures. Materials used for shipbuilding. Unit and block methods of ship construction. Welding of submarine steels. Welding of offshore structures.						
RAILWAYS						
Materials used for locomotive subassemblies, rail coaches and wagons. Welding processes used for railway components and rails.						

UNIT - V		WELDING OF AEROSPACE AND AUTOMOBILE		9
AEROSPACE				
Main parts of aerospace structures. Materials used in aircraft construction. Methods of aircraft construction. Welding of aircraft structures.				
AUTOMOBILE				
Main parts of automobiles. Materials used for automobile subassemblies. Welding of automobile components.				
L:45, Total:45 Hours				
Weightage:				
Continuous Assessment 40%				
End Semester Examinations 60%				
REFERENCE BOOKS:				
1.	R.S. Parmar, Welding Engineering and Technology, 3rd Edition, Khanna Publishers, 2020.			
2.	Howard B. Cary and Scott Helzer, Modern Welding Technology, 7th Edition, Pearson, 2020.			
3.	AWS Welding Handbook, Volume 1: Welding Science and Technology, 11th Edition, AWS, 2021.			
4.	AWS Welding Handbook, Volume 2: Welding Processes, 10th Edition, AWS, 2019.			
5.	John Hicks, Welded Joint Design, 4th Edition, Industrial Press, 2018.			
6.	ASM Handbook Volume 6A, Welding Fundamentals and Processes, ASM International, 2017.			
7.	Kihara and Masubuchi, Welding and Fabrication of Ship Structures, Springer, Reprint Edition, 2019.			
E-RESOURCES:				
1.	NPTEL – Welding Technology.			
2.	NPTEL – Pressure Vessel Design and Fabrication.			
3.	NPTEL – Shipbuilding and Marine Structures.			
4.	American Welding Society (AWS) Learning Resources.			
5.	ASM International Welding Resources.			
6.	International Institute of Welding (IIW) Technical Resources.			
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to			Mapping POs	Mapping PSOs
CO1	Explain the materials, welding processes and fabrication techniques used in structural, pressure vessel, piping, shipbuilding, aerospace and automobile industries.		-	-
CO2	Apply appropriate welding processes, materials and fabrication practices for industrial welding applications.		PO3	PSO1
CO3	Analyze welding procedures, material selection and fabrication challenges associated with specialized industrial applications.		PO1	PSO1, PSO2
CO4	Evaluate welding requirements, quality control measures and inspection procedures used in industrial fabrication and prepare technical reports.		PO1, PO2	PSO1, PSO2
CO5	Develop suitable welding procedures and fabrication methodologies for structural, pressure vessel, transportation and advanced engineering applications.		PO1, PO2, PO3	PSO1, PSO2, PSO3

The Course Articulation Matrix (CAM) for defined Cos

	P01	P02	P03	PS01	PS02
CO1					
CO2			2	3	1
CO3	3		1	3	2
CO4	2	3	1	3	3
CO5	3	2	2	3	3

Activities:

1.	Activity I (CO4): Technical Poster Presentation on Industrial Applications of Welding Technology
2.	Activity II (CO5): Technical Seminar Presentation on Advanced Welding Applications in Manufacturing Industries (Independent Study)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content
2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization
3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information
5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Topic Selection & Literature Review	20	Recent and highly relevant topic with good literature support	Relevant topic	Basic topic
2.	Technical Understanding	20	Demonstrates excellent conceptual understanding	Good understanding	Limited understanding

3.	Industrial Applications / Case Study	20	Well-supported with industrial examples and technical discussion	Adequate examples	Few examples
4.	Technical Report Preparation	20	Professional report with proper references and formatting	Good report	Incomplete report
5.	Seminar Presentation & Interaction	20	Excellent presentation, confidence, and response to questions	Good presentation	Poor communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Strength = 3 (if percentage >20%); Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%).

26WTE04	FOUNDRY PROCESSES			SEMESTER		II	
Prerequisites			Category	ES(PE)	Credits	3	
Manufacturing Technology, Engineering Materials and Metallurgy			Hours/ Semester	L	T	P	TH
				45	0	0	45
COURSE OBJECTIVES							
1.	To understand the fundamentals of foundry technology, moulding materials and pattern making.						
2.	To gain knowledge on various moulding, casting and advanced foundry processes.						
3.	To learn the principles of gating and riser design for quality castings.						
4.	To understand quality control, inspection, automation and environmental aspects in foundries.						
5.	To study foundry metallurgy, melting practices and solidification behaviour of engineering alloys.						
UNIT – I		MOULDING MATERIALS AND PATTERNS					9
Introduction to foundry operations. Patterns – functions, types, allowances, selection of pattern materials, colour codes. Core boxes. Moulding practice. Ingredients of moulding sand and core sand. Testing of moulding sands. Sand preparation methods and equipment.							
UNIT - II		MOULDING AND CASTING TECHNIQUES					9
Sand moulding: Green sand moulding, dry sand moulding, skin dry sand moulding. Shell moulding. Carbon dioxide process. Permanent mould casting. Die casting. Centrifugal casting. Plaster mould casting. Investment casting. Squeeze casting. Full mould process. Rheo casting and Thixo casting processes.							
UNIT - III		DESIGN OF CASTINGS					9
Elements of gating system. Types and design of gating systems with examples. Functions and types of risers. Chvorinov’s rule. Design and positioning of risers. Use of chills and exothermic compounds. Riser efficiency and yield calculations. Introduction to software applications in foundry engineering.							
UNIT - IV		QUALITY CONTROL, FETTLING, INSPECTION AND AUTOMATION					9
Quality control in foundries. Composition control in steels and cast irons. Charge calculations. Cleaning and repair of castings. Casting defects and remedies. Heat treatment of castings. Inspection of castings. Principles of mechanization and automation. Foundry layout. Sand reclamation and pollution control in foundries.							
UNIT - V		FOUNDRY METALLURGY					9
Melting practices and metallurgy of steels, alloy steels, cast irons, aluminium alloys, copper alloys and magnesium alloys. Solidification of castings. Fluidity and factors affecting fluidity. Measurement of fluidity. Inoculation of cast irons. Modification of Al-Si alloys. Slag-metal reactions. Gases in metals and degassing techniques.							
L:45, Total:45 Hours							
Weightage: Continuous Assessment 40% End Semester Examinations 60%							

REFERENCE BOOKS:			
1.	Heine R.W., Loper C.R. and Rosenthal P.C., <i>Principles of Metal Casting</i> , Tata McGraw-Hill Education, 2nd Edition, 2011.		
2.	Jain P.L., <i>Principles of Foundry Technology</i> , Tata McGraw-Hill Education, 6 th Edition, 2018.		
3.	Rao P.N., <i>Manufacturing Technology – Foundry, Forming and Welding</i> , McGraw Hill Education, 5 th Edition, 2018.		
4.	Campbell J., <i>Complete Casting Handbook</i> , 2 nd Edition, Elsevier, 2015.		
5.	Beeley P.R., <i>Foundry Technology</i> , 2 nd Edition, Butterworth-Heinemann, 2001.		
6.	Stefanescu D.M., <i>Science and Engineering of Casting Solidification</i> , 3 rd Edition, Springer, 2015.		
7.	ASM Handbook Volume 15, <i>Casting</i> , ASM International, 2018.		
8.	Jain R.K., <i>Production Technology</i> , Khanna Publishers, 2017.		
E-RESOURCES:			
1.	NPTEL – Manufacturing Processes I & II, IIT Kharagpur.		
2.	NPTEL – Metal Casting and Foundry Engineering, IIT Roorkee.		
3.	American Foundry Society (AFS) Technical Resources.		
4.	ASM International Digital Library – Casting and Solidification.		
5.	e-PG Pathshala – Foundry Technology Modules.		
6.	SWAYAM Courses on Manufacturing and Foundry Processes.		
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain the fundamentals of moulding materials, pattern making, casting techniques, foundry metallurgy and quality control practices.		
CO2	Apply moulding methods, casting processes and foundry practices for producing engineering castings.	PO1	PSO2
CO3	Analyze gating systems, riser designs, casting defects, yield calculations and solidification behaviour of castings.	PO1	PSO1
CO4	Evaluate casting processes, inspection methods, automation techniques and metallurgical aspects for quality improvement.	PO2, PO3	PSO1, PSO2
CO5	Develop suitable foundry solutions by integrating casting design, metallurgy, quality control and automation concepts.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined Cos

	P01	P02	P03	PS01	PS02
CO1					
CO2	3				2
CO3	3			2	
CO4		3	3	2	2
CO5	3	3	3	3	3

Activities:

1.	Activity I (CO4): Technical Poster Presentation on Modern Foundry Processes and Casting Technologies
2.	Activity 2 Technical Seminar Presentation on Advanced Foundry Practices and Casting Applications (Independent Study)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content
2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization
3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information
5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Topic Selection & Literature Review	20	Recent and highly relevant topic with good literature support	Relevant topic	Basic topic

2.	Technical Understanding	20	Demonstrates excellent conceptual understanding	Good understanding	Limited understanding
3.	Industrial Applications / Case Study	20	Well-supported with industrial examples and technical discussion	Adequate examples	Few examples
4.	Technical Report Preparation	20	Professional report with proper references and formatting	Good report	Incomplete report
5.	Seminar Presentation & Interaction	20	Excellent presentation, confidence, and response to questions	Good presentation	Poor communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Strength = 3 (if percentage >20%); Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%).

26WTE05	MATERIALS CHARACTERIZATION			SEMESTER		II	
Prerequisites			Category	ES(PE)	Credits	3	
Engineering Materials and Metallurgy			Hours/ Semester	L	T	P	TH
				45	0	0	45
COURSE OBJECTIVES							
1.	To acquire knowledge on metallographic techniques and specimen preparation methods for microstructural characterization.						
2.	To understand the principles and applications of X-ray diffraction techniques in materials characterization.						
3.	To gain knowledge on advanced microscopy techniques for microstructural and compositional analysis.						
4.	To understand chemical and thermal analysis methods used in material evaluation.						
5.	To develop the ability to select suitable characterization techniques for metallurgical investigations, welding research and industrial applications.						
UNIT – I		METALLOGRAPHIC TECHNIQUES					9
Resolution, depth of focus and components and working of Metallurgical Microscope, polarized light, phase contrast, interference, hot stage and quantitative metallographic techniques – grain size and volume fraction. In-situ metallography, specimen preparation techniques.							
UNIT - II		X-RAY DIFFRACTION TECHNIQUES					9
Continuous and Characteristic spectrum – Bragg’s law – Diffraction methods – Laue, rotating crystal and powder methods. Intensity of diffracted beams – structure factor calculations.							
UNIT - III		APPLICATIONS OF X-RAY DIFFRACTION					9
Diffractometer – general features and optics – proportional, scintillation and Geiger counters. X-ray diffraction applications in determination of crystal structure, lattice parameter and residual stress – quantitative phase estimation.							
UNIT - IV		ELECTRON MICROSCOPY					9
Construction and operation of Transmission Electron Microscopy (TEM) – diffraction effects and image formation, specimen preparation techniques, elemental analysis by wavelength dispersive and energy dispersive systems. Construction and operation of Scanning Electron Microscopy (SEM), Scanning Transmission Electron Microscopy (STEM), Scanning Probe Microscope (SPM) and Atomic Force Microscopy (AFM). Evaluation of samples using advanced microscopy techniques.							
UNIT - V		ADVANCED CHEMICAL AND THERMAL ANALYSIS METHODS					9
X-ray fluoroscopy, Spectroscopy – principles, Atomic Absorption Spectroscopy (AAS), Optical Emission Spectroscopy (OES), Auger Spectroscopy. Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC), Thermo Gravimetric Analysis (TGA), Stress analysis.							
L:45, Total:45 Hours							
Weightage:							
Continuous Assessment 40%							
End Semester Examinations 60%							

REFERENCE BOOKS:

1.	P.C. Angelo and R. Subramanian, <i>Materials Characterization: Introduction to Microscopic and Spectroscopic Methods</i> , 2nd Edition, Elsevier, 2018.
2.	Philips V.A., <i>Modern Metallographic Techniques and Their Applications</i> , Wiley-Interscience, 1971.
3.	B.D. Cullity and S.R. Stock, <i>Elements of X-Ray Diffraction</i> , 3rd Edition, Pearson, 2014.
4.	ASM Handbook, Volume 10, <i>Materials Characterization</i> , ASM International, 2019.
5.	D.B. Williams and C.B. Carter, <i>Transmission Electron Microscopy</i> , 2nd Edition, Springer, 2019.
6.	R.E. Smallman and A.H.W. Ngan, <i>Modern Physical Metallurgy and Materials Engineering</i> , 8th Edition, Elsevier, 2014.
7.	M.H. Loretto, <i>Electron Beam Analysis of Materials</i> , Springer, 2013.

E-RESOURCES:

1.	NPTEL – Materials Characterization.
2.	NPTEL – Crystallography and X-Ray Diffraction.
3.	NPTEL – Electron Microscopy and Microstructural Characterization.
4.	ASM International Digital Library.
5.	Springer Materials Database.
6.	TMS Learning Resources on Materials Characterization

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain metallographic techniques, X-ray diffraction principles, electron microscopy methods and thermal analysis techniques used for materials characterization.	-	-
CO2	Apply metallographic, X-ray diffraction and microscopy techniques for characterization of engineering materials and weldments.	PO3	PSO1
CO3	Analyze crystal structures, microstructures, phase constituents and compositional variations using advanced characterization techniques.	PO1	PSO1
CO4	Evaluate engineering materials and welded components through microscopy, diffraction, chemical and thermal analysis methods and prepare technical reports.	PO1, PO2	PSO1, PSO2
CO5	Develop characterization methodologies for research investigations, failure analysis and process optimization involving advanced materials and weldments.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined Cos

	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			2	3	
CO3	3		1	3	1
CO4	2	3	1	3	2
CO5	3	2	3	3	2

Activities:

1.	Activity I (CO4): Technical Poster Presentation on Materials Characterization Techniques
2.	Technical Seminar Presentation on Advanced Materials Characterization Techniques (Independent Study)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content
2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization
3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information
5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Topic Selection & Literature Review	20	Recent and highly relevant topic with good literature support	Relevant topic	Basic topic
2.	Technical Understanding	20	Demonstrates excellent conceptual understanding	Good understanding	Limited understanding
3.	Industrial Applications / Case Study	20	Well-supported with industrial examples and technical discussion	Adequate examples	Few examples
4.	Technical Report Preparation	20	Professional report with proper references and formatting	Good report	Incomplete report
5.	Seminar Presentation & Interaction	20	Excellent presentation, confidence, and response to questions	Good presentation	Poor communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Strength = 3 (if percentage >20%); Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%).

26WTE06	FINITE ELEMENT ANALYSIS			SEMESTER		II	
Prerequisites			Category	ES(PE)	Credits	3	
Engineering Mathematics			Hours/ Semester	L	T	P	TH
				45	0	0	45
COURSE OBJECTIVES							
1.	To provide the fundamental concepts of finite element formulation and numerical solution techniques.						
2.	To develop the ability to model and analyze engineering problems using finite element methods.						
3.	To understand isoparametric elements and numerical integration techniques for two-dimensional and three-dimensional problems.						
4.	To study nonlinear and dynamic finite element analysis applicable to engineering and metallurgical systems.						
5.	To apply finite element methods for solving heat transfer, solid mechanics and fluid flow problems.						
UNIT – I		TWO DIMENSIONAL PROBLEMS					9
Poisson equation, Laplace equation, weak form, element matrices for triangular and rectangular elements, evaluation of integrals, assembly procedure, axisymmetric problems and applications. Conduction and convection heat transfer, torsional cylindrical member, transient analysis, theory of elasticity, plane strain, plane stress, axisymmetric problems and principle of virtual displacement.							
UNIT - II		ISOPARAMETRIC ELEMENTS AND ITS APPLICATIONS					9
Introduction to isoparametric formulation, bilinear quadrilateral elements, quadratic quadrilateral elements, hexahedral elements, numerical integration, Gauss quadrature, static condensation, load considerations, stress calculations and examples of two-dimensional and three-dimensional applications.							
UNIT - III		NON-LINEAR PROBLEMS AND ERROR ESTIMATES					9
Introduction, iterative techniques, material nonlinearity, elastoplasticity, plasticity, viscoplasticity, geometric nonlinearity, large displacement formulation, applications in metal forming processes and contact problems, error norms and convergence rates, h-refinement with adaptivity and adaptive refinement techniques							
UNIT - IV		DYNAMIC PROBLEMS					9
Direct formulation, free vibration response, transient response, forced response, solution procedures, subspace iterative technique, Houbolt method, Wilson method, Newmark method and engineering applications.							
UNIT - V		FLUID MECHANICS					9
Governing equations of fluid mechanics, inviscid and incompressible flow, potential formulations, slow non-Newtonian flow, Navier-Stokes equation, steady-state and transient solutions.							
L:45, Total:45 Hours							
Weightage:							
Continuous Assessment 40%							
End Semester Examinations 60%							

REFERENCE BOOKS:			
1.	J.N. Reddy, <i>An Introduction to the Finite Element Method</i> , 4th Edition, McGraw-Hill Education, 2019.		
2.	O.C. Zienkiewicz, R.L. Taylor and J.Z. Zhu, <i>The Finite Element Method: Its Basis and Fundamentals</i> , 8th Edition, Elsevier, 2021.		
3.	S.S. Rao, <i>The Finite Element Method in Engineering</i> , 6th Edition, Butterworth-Heinemann, 2018.		
4.	Daryl L. Logan, <i>A First Course in the Finite Element Method</i> , 7th Edition, Cengage Learning, 2017.		
5.	T.R. Chandrupatla and A.D. Belegundu, <i>Introduction to Finite Elements in Engineering</i> , 5th Edition, Pearson, 2020.		
6.	Klaus-Jürgen Bathe, <i>Finite Element Procedures</i> , Prentice Hall, Reprint Edition, 2019.		
7.	Robert D. Cook, David S. Malkus and Michael E. Plesha, <i>Concepts and Applications of Finite Element Analysis</i> , 4th Edition, Wiley, 2018.		
E-RESOURCES:			
1.	NPTEL – Finite Element Analysis.		
2.	NPTEL – Computational Mechanics.		
3.	NPTEL – Finite Element Methods for Engineering Applications.		
4.	MIT OpenCourseWare – Finite Element Procedures.		
5.	ANSYS Learning Resources and Tutorials.		
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain the fundamentals of finite element formulation, element characteristics and numerical solution procedures used in engineering analysis.	-	-
CO2	Apply finite element formulations to solve two-dimensional, axisymmetric and heat transfer problems.	PO3	PSO3
CO3	Analyze engineering problems involving isoparametric elements, nonlinear material behavior and contact phenomena using finite element techniques.	PO1	PSO3
CO4	Evaluate static, dynamic and fluid flow problems through finite element simulations and prepare technical reports.	PO1, PO2	PSO2, PSO3
CO5	Develop finite element models for research and industrial applications involving welded structures, manufacturing processes and engineering systems.	PO1, PO2, PO3	PSO2, PSO3

The Course Articulation Matrix (CAM) for defined Cos

	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			2		1
CO3	3		1		1
CO4	2	3	1		2
CO5	3	2	3		2

Activities:

1.	Activity I (CO4): Technical Poster Presentation on Finite Element Analysis Techniques and Engineering Applications
2.	Technical Seminar Presentation on Advanced Finite Element Analysis Applications (Independent Study)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content
2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization
3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information
5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Topic Selection & Literature Review	20	Recent and highly relevant topic with good literature support	Relevant topic	Basic topic

2.	Technical Understanding	20	Demonstrates excellent conceptual understanding	Good understanding	Limited understanding
3.	Industrial Applications / Case Study	20	Well-supported with industrial examples and technical discussion	Adequate examples	Few examples
4.	Technical Report Preparation	20	Professional report with proper references and formatting	Good report	Incomplete report
5.	Seminar Presentation & Interaction	20	Excellent presentation, confidence, and response to questions	Good presentation	Poor communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Strength = 3 (if percentage >20%); Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%).

26WTE07	INDUSTRIAL SAFETY	SEMESTER			II
Prerequisites		Category	ES(PE)	Credits	3
Manufacturing Technology		Hours/ Semester	L	T	P
			45	0	0
COURSE OBJECTIVES					
1.	To impart knowledge on industrial safety practices, accident prevention and statutory safety requirements in industries.				
2.	To understand maintenance engineering principles and maintenance management practices.				
3.	To study wear, corrosion mechanisms and their prevention techniques.				
4.	To develop skills in fault diagnosis and troubleshooting of industrial equipment.				
5.	To understand periodic and preventive maintenance procedures for industrial systems.				
UNIT – I INDUSTRIAL SAFETY 9					
Accident, causes, types, results and control. Mechanical and electrical hazards, types, causes and preventive procedures. Salient provisions of Factories Act 1948 related to health and safety. Wash rooms, drinking water facilities, lighting, cleanliness, fire safety, machine guarding, pressure vessels and safety requirements. Safety colour codes. Fire prevention and fire-fighting equipment and methods.					
UNIT - II FUNDAMENTALS OF MAINTENANCE ENGINEERING 9					
Definition and objectives of maintenance engineering. Primary and secondary functions of maintenance department. Types of maintenance. Tools used for maintenance and their applications. Maintenance cost and replacement economy. Service life of industrial equipment.					
UNIT - III WEAR AND CORROSION AND THEIR PREVENTION 9					
Wear – types, causes, effects and reduction methods. Lubricants – types and applications. Lubrication methods: screw down grease cup, pressure grease gun, splash lubrication, gravity lubrication, wick feed lubrication, side feed lubrication and ring lubrication. Corrosion – definition, principles, factors affecting corrosion, types of corrosion and corrosion prevention methods.					
UNIT - IV FAULT TRACING 9					
Concept and importance of fault tracing. Decision tree concept, need and applications. Sequence of fault finding activities. Decision tree development for machine tools, hydraulic systems, pneumatic systems, automotive systems, thermal equipment and electrical equipment. Types of faults in machine tools and their causes.					
UNIT - V PERIODIC AND PREVENTIVE MAINTENANCE 9					
Periodic inspection – concept and importance. Degreasing, cleaning, repairing and overhauling procedures. Overhauling of mechanical components and electrical motors. Common motor troubles and remedies. Repair complexities. Preventive maintenance – definition, need, procedures and advantages. Preventive maintenance schedules for machine tools, pumps, compressors and diesel generator sets. Repair cycle concept and significance.					
L:45, Total:45 Hours					
Weightage:					
Continuous Assessment 40%					
End Semester Examinations 60%					

REFERENCE BOOKS:					
1.	R.K. Jain, <i>Industrial Safety, Health and Environment Management Systems</i> , Khanna Publishers, 2020.				
2.	B.S. Dhillon, <i>Engineering Maintenance: A Modern Approach</i> , CRC Press, 2019.				
3.	Heinz P. Bloch, <i>Practical Machinery Management for Process Plants</i> , Elsevier, 2018.				
4.	Higgins and Mobley, <i>Maintenance Engineering Handbook</i> , 8th Edition, McGraw Hill, 2020.				
5.	ASM Handbook Volume 13A, <i>Corrosion: Fundamentals, Testing and Protection</i> , ASM International, 2021.				
6.	N.V.S. Raju, <i>Industrial Safety Engineering</i> , Cengage Learning, 2017.				
7.	R.C. Mishra and K. Pathak, <i>Maintenance Engineering and Management</i> , PHI Learning, 2018				
E-RESOURCES:					
1.	NPTEL – Industrial Safety Engineering.				
2.	NPTEL – Maintenance Engineering.				
3.	NPTEL – Corrosion Engineering.				
4.	OSHA Safety Standards and Guidelines.				
5.	Directorate General Factory Advice Service and Labour Institutes (DGFASLI) Resources.				
6.	Welding Institute Online Technical Resources.				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs		
CO1	Explain industrial safety requirements, maintenance practices, wear mechanisms, corrosion phenomena and fault tracing techniques used in industrial systems.	-	-		
CO2	Apply industrial safety regulations, maintenance procedures and corrosion prevention techniques in engineering applications.	PO3	PSO1		
CO3	Analyze equipment failures, wear mechanisms, corrosion problems and maintenance requirements using engineering principles.	PO1	PSO1		
CO4	Evaluate industrial safety practices, fault diagnosis procedures and maintenance schedules and prepare technical reports.	PO1, PO2	PSO2		
CO5	Develop safety management plans, maintenance programs and fault diagnosis strategies for industrial equipment and manufacturing systems.	PO1, PO2, PO3	PSO2, PSO3		
The Course Articulation Matrix (CAM) for defined COs					
	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			2	2	1
CO3	3		1	3	1
CO4	2	3	1	1	3
CO5	3	2	2	1	3

Activities:

1.	Activity I (CO4): Technical Poster Presentation on Industrial Safety Practices and Hazard Control
2.	Technical Seminar Presentation on Industrial Safety Management and Accident Prevention (Independent Study)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content
2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization
3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information
5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Topic Selection & Literature Review	20	Recent and highly relevant topic with good literature support	Relevant topic	Basic topic
2.	Technical Understanding	20	Demonstrates excellent conceptual understanding	Good understanding	Limited understanding
3.	Industrial Applications / Case Study	20	Well-supported with industrial examples and technical discussion	Adequate examples	Few examples
4.	Technical Report Preparation	20	Professional report with proper references and formatting	Good report	Incomplete report
5.	Seminar Presentation & Interaction	20	Excellent presentation, confidence, and response to questions	Good presentation	Poor communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12			12	2
C02	24	24			24	2
C03	24	24			24	2
C04			40		20	3
C05				40	20	3
Total	60	60	40	40	100	

Note: Strength = 3 (if percentage >20%); Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%).

26WTE08	REPAIR WELDING AND RECLAMATION		SEMESTER		II	
Prerequisites		Category	ES(PE)	Credits		3
Manufacturing Technology, Engineering Materials and Metallurgy		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To understand engineering principles, procedures and techno-economic aspects involved in repair welding.					
2.	To gain knowledge on repair welding techniques used in pipelines, pressure vessels, heat exchangers and high-temperature components.					
3.	To understand reclamation methods and surfacing techniques for wear-resistant applications.					
4.	To study maintenance welding practices in nuclear power plants and other critical engineering systems.					
5.	To evaluate surface coatings and reclamation weldments using testing and characterization techniques.					
UNIT - I	REPAIR WELDING					9
Engineering aspects of repair. Factors to be considered for repair welding. Techno-economic considerations. Repair welding procedures for steel castings and cast irons. Full mould process. AWA bath tub test for cast iron repair. Special procedures to avoid post-repair stress relief heat treatment. Half bead and temper bead techniques. Usage of nickel-based filler metals.						
UNIT - II	REPAIR TECHNIQUES FOLLOWED IN SPECIFIC APPLICATIONS					9
Repair of damaged bends in gas transmission pipelines. Heat exchanger repair techniques – explosive expansion and plugging. Repair of creep-damaged high-temperature components. Repair of cracked petroleum pressure vessels and reactors.						
UNIT - III	RECLAMATION					9
Types of wear. Wear resistant materials. Selection of materials for various wear applications. Reclamation surfacing techniques. Selection of welding processes for reclamation applications.						
UNIT - IV	MAINTENANCE WELDING IN NUCLEAR POWER PLANTS					9
Integration of repair and maintenance activities into ongoing plant operations. Radiation protection requirements. Steam generator repair. Plugging techniques. Maintenance welding practices in nuclear power plants.						
UNIT - V	EVALUATION OF SURFACE COATINGS					9
Various hardness testing methods. Non-destructive evaluation of surface coatings. Characterization of coatings. Photo-thermal imaging techniques. Case studies on coating selection, application and material combinations.						
L:45, Total:45 Hours						
Weightage:						
Continuous Assessment 40%						
End Semester Examinations 60%						

REFERENCE BOOKS:					
1.	<i>Weld Surfacing and Hardfacing</i> , The Welding Institute, 1987.				
2.	Nagendra Reddy A., <i>Maintenance Welding Made Easy</i> , Jaico Publishing House, New Delhi, 2004.				
3.	<i>Recommended Practice for Repair Welding and Fabrication Welding of Steel Castings</i> , Steel Founders' Society of America, 1981.				
4.	Lim Cottrell C., <i>Welding Cast Irons</i> , The Welding Institute, 1991.				
5.	Nadkarni S.V., <i>Modern Arc Welding Technology</i> , Oxford & IBH Publishing Co., 1996.				
6.	ASM Handbook Volume 6A, <i>Welding Fundamentals and Processes</i> , ASM International, 2017.				
7.	AWS Welding Handbook, Volume 2, <i>Welding Processes</i> , 9th Edition, American Welding Society, 2014.				
E-RESOURCES:					
1.	NPTEL – Welding Technology and Weldability.				
2.	NPTEL – Surface Engineering and Coatings.				
3.	ASM International Digital Library.				
4.	American Welding Society (AWS) Learning Resources.				
5.	TWI Knowledge Hub – Repair Welding and Reclamation.				
6.	IAEA Technical Reports on Maintenance Welding in Nuclear Power Plants.				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs	Mapping PSOs
CO1	Explain repair welding principles, reclamation techniques, maintenance welding practices and coating evaluation methods used in engineering applications.			-	-
CO2	Apply repair welding and reclamation procedures for castings, pipelines, pressure vessels and industrial components.			PO3	PSO1
CO3	Analyze wear problems, failure mechanisms and suitability of repair and reclamation techniques for specific industrial applications.			PO1	PSO1, PSO2
CO4	Evaluate repair welds, reclaimed surfaces and protective coatings using testing, characterization and inspection techniques and prepare technical reports.			PO1, PO2	PSO1, PSO2
CO5	Develop suitable repair welding, reclamation and maintenance strategies for industrial components considering service requirements, reliability and economy.			PO1, PO2, PO3	PSO1, PSO2, PSO3
The Course Articulation Matrix (CAM) for defined COs					
	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			2	3	1
CO3	3		1	3	2
CO4	2	3	1	2	3
CO5	3	2	3	3	3

Activities:

1.	Activity I (CO4): Technical Poster Presentation on Repair Welding and Reclamation Techniques
2.	Activity II (CO5): Technical Seminar Presentation on Industrial Applications of Repair Welding and Reclamation (Independent Study)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content
2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization
3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information
5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Topic Selection & Literature Review	20	Recent and highly relevant topic with good literature support	Relevant topic	Basic topic
2.	Technical Understanding	20	Demonstrates excellent conceptual understanding	Good understanding	Limited understanding
3.	Industrial Applications / Case Study	20	Well-supported with industrial examples and technical discussion	Adequate examples	Few examples
4.	Technical Report Preparation	20	Professional report with proper references and formatting	Good report	Incomplete report
5.	Seminar Presentation & Interaction	20	Excellent presentation, confidence, and response to questions	Good presentation	Poor communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Strength = 3 (if percentage >20%); Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%).

26WTE09	TOTAL QUALITY SYSTEM AND ENGINEERING			SEMESTER		III	
Prerequisites			Category	ES(PE)	Credits	3	
NIL			Hours/ Semester	L	T	P	TH
				45	0	0	45
COURSE OBJECTIVES							
1.	To understand the principles and philosophies of Total Quality Management (TQM) in engineering industries.						
2.	To study quality management systems and international standards used in manufacturing organizations.						
3.	To learn modern quality improvement techniques and continuous improvement methodologies.						
4.	To develop knowledge of statistical process control and process capability analysis.						
5.	To understand acceptance sampling techniques and quality assurance practices						
UNIT - I		INTRODUCTION					9
Principles of Quality Management. Pioneers of Total Quality Management. Quality Cost. Quality System. Customer Orientation. Benchmarking. Re-engineering. Concurrent Engineering.							
UNIT - II		MANAGEMENT SYSTEMS					9
Leadership. Organizational Structure. Team Building. Information Systems and Documentation. Quality Auditing. Overview of ISO 9001:2015, IATF 16949:2016 (formerly ISO/TS 16949), ISO 14001:2015, ISO 45001:2018 (successor of OHSAS 18001), ISO 50001:2018.							
UNIT - III		TECHNIQUES OF TQM					9
Failure Mode and Effects Analysis (FMEA). Quality Function Deployment (QFD). Quality Circles. KAIZEN. POKA-YOKE. Taguchi Methods. 5S. Six Sigma. Total Productive Maintenance (TPM). Single Vendor Concept. Just-In-Time (JIT).							
UNIT - IV		STATISTICAL QUALITY CONTROL					9
Methods and Philosophy of Statistical Process Control (SPC). Control Charts for Variables and Attributes. Cumulative Sum (CUSUM) Charts. Exponentially Weighted Moving Average (EWMA) Control Charts. Other SPC Techniques. Process Capability Analysis.							
UNIT - V		ACCEPTANCE SAMPLING					9
Acceptance sampling Problem –Single Sampling Plans for Attributes –Double, Multiple and sequential sampling, Military standards – The Dodge – Romig Sampling plans.							
L:45, Total:45 Hours							
Weightage: Continuous Assessment 40% End Semester Examinations 60%							

REFERENCE BOOKS:					
1.	Dale H. Besterfield, Total Quality Management , 4th Edition, Pearson Education, 2018.				
2.	James R. Evans and William M. Lindsay, Managing for Quality and Performance Excellence , 11 th Edition, Cengage Learning, 2020.				
3.	Douglas C. Montgomery, Introduction to Statistical Quality Control , 8th Edition, Wiley, 2020.				
4.	Amitava Mitra, Fundamentals of Quality Control and Improvement , 5th Edition, Wiley, 2021.				
5.	Tapan K. Bose, Quality Management and Quality Performance , Pearson Education, 2019.				
6.	Pyzdek Thomas and Paul Keller, The Six Sigma Handbook , 5th Edition, McGraw-Hill, 2022.				
7.	Juran J.M. and De Feo J.A., Juran's Quality Handbook , 7th Edition, McGraw-Hill, 2017.				
E-RESOURCES:					
1.	NPTEL – Total Quality Management.				
2.	NPTEL – Statistical Quality Control.				
3.	American Society for Quality (ASQ) Learning Resources.				
4.	ISO Management System Standards Resources.				
5.	Six Sigma and Lean Manufacturing Learning Modules.				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs		
CO1	Explain the principles of quality management, management systems, quality improvement techniques and statistical quality control methods.	-	-		
CO2	Apply TQM tools, quality management systems and quality improvement techniques in manufacturing and engineering environments.	PO3	PSO2		
CO3	Analyze quality problems using statistical process control, process capability analysis and quality management tools.	PO1	PSO2		
CO4	Evaluate organizational quality systems, auditing practices and sampling plans and prepare technical reports for quality improvement.	PO1, PO2	PSO2		
CO5	Develop integrated quality management and continuous improvement strategies for manufacturing and welding industries.	PO1, PO2, PO3	PSO1, PSO2		
The Course Articulation Matrix (CAM) for defined COs					
	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			2	1	3
CO3	3		1	1	3
CO4	2	3	1	1	3
CO5	3	2	2	2	3

Activities:

1.	Activity I (CO4): Technical Poster Presentation on Quality Management Systems and Continuous Improvement Tools
2.	Activity II Technical Seminar Presentation on Quality Engineering Practices in Manufacturing Industries (Independent Study)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content
2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization
3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information
5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Topic Selection & Literature Review	20	Recent and highly relevant topic with good literature support	Relevant topic	Basic topic
2.	Technical Understanding	20	Demonstrates excellent conceptual understanding	Good understanding	Limited understanding
3.	Industrial Applications / Case Study	20	Well-supported with industrial examples and technical discussion	Adequate examples	Few examples

4.	Technical Report Preparation	20	Professional report with proper references and formatting	Good report	Incomplete report
5.	Seminar Presentation & Interaction	20	Excellent presentation, confidence, and response to questions	Good presentation	Poor communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Strength = 3 (if percentage >20%); Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%).

26WTE10	AUTOMATION AND ROBOTS IN WELDING		SEMESTER		III	
Prerequisites		Category	ES(PE)	Credits	3	
Manufacturing Technology		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To understand the need, principles and applications of automation in welding and allied processes.					
2.	To study automated welding equipment, arc motion devices and work handling systems.					
3.	To understand welding controls, sensors and dedicated automated welding systems.					
4.	To gain knowledge on robotic welding systems and industrial robot configurations.					
5.	To develop skills in selecting and implementing automation technologies for welding industries.					
UNIT - I	AUTOMATION OF ARC WELDING PROCESSES					9
Need for automation in welding. Introduction to semi-automatic, mechanized, automatic, robotic and adaptive control welding. Automatic welding systems. Factors affecting welding productivity. Advantages and disadvantages of welding automation. Arc welding processes suitable for automation and degree of automation in GMAW, FCAW, SAW, GTAW, PAW and Stud Welding.						
UNIT - II	AUTOMATION OF OTHER RELATED PROCESSES					9
Degree of automation in brazing and soldering processes. Automation in resistance welding, electron beam welding, laser beam welding and solid-state welding processes. Automation in oxygen cutting, arc cutting, plasma cutting, laser beam cutting and thermal spraying.						
UNIT - III	AUTOMATED WELDING EQUIPMENT, ARC AND WORK MOTION DEVICES					9
Welding power sources. Electrode wire feeders and wire dispensing systems including spools, coils, rods, drums and pay-off packs. Typical adapters and spiders. Types and functions of welding torches used in automated welding. Standardized arc motion devices – tractors, carriages, side beam carriages, manipulators and gantry carriages. Work motion devices – universal positioners, turning rolls and head-stock/tail-stock positioners. Combination of arc and work motion devices.						
UNIT - IV	STANDARDIZED ARC WELDING MACHINES, CONTROLS AND SENSORS					9
Standardized arc welding equipment. Types of standardized welding machines – seamers, welding lathes, weld-around machines, nozzle welders, bore welders, beam welders and strip welders. Laser welding cells and Plasma Transferred Arc (PTA) overlay systems. Automatic welding of pipes and tubes. Dedicated automatic welding machines. Temporary portable automated tooling. Controls and sensors for automated arc welding.						
UNIT - V	ROBOTIC ARC WELDING					9
Flexible automation of arc welding. Robotic arc welding systems. Types of welding robots – revolute, Cartesian, spherical, cylindrical and SCARA robots. Hybrid welding robots. Features of welding robots. Robotic part-holding positioners. Robot teaching methods. Specification of welding robots. Industrial applications and case studies of robotic welding.						
L:45, Total:45 Hours						

Weightage: Continuous Assessment 40% End Semester Examinations 60%			
REFERENCE BOOKS:			
1.	Richard L. Little, Welding and Welding Automation , Industrial Press Inc., 2018.		
2.	Cary Howard B. and Scott Helzer, Modern Welding Technology , 7th Edition, Pearson Education, 2020.		
3.	Groover M.P., Automation, Production Systems and Computer Integrated Manufacturing , 5th Edition, Pearson, 2020.		
4.	Mikell P. Groover, Industrial Robotics: Technology, Programming and Applications , McGraw Hill, 2019.		
5.	SeropeKalpakjian and Steven Schmid, Manufacturing Engineering and Technology , 8th Edition, Pearson, 2021.		
6.	Yoram Koren, Robotics for Engineers , McGraw Hill Education, 2018.		
7.	AWS Welding Handbook, Volume 2: Welding Processes , 10th Edition, AWS, 2019.		
E-RESOURCES:			
1.	NPTEL – Industrial Automation and Control.		
2.	NPTEL – Robotics.		
3.	NPTEL – Automation in Manufacturing Systems.		
4.	FANUC Welding Robot Learning Resources.		
5.	ABB Robotics and Welding Automation Resources.		
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain automation principles, automated welding equipment, welding controls, sensors and robotic welding systems.	-	-
CO2	Apply automation concepts and robotic technologies for welding and allied manufacturing processes.	PO3	PSO2
CO3	Analyze automated welding systems, motion devices, sensors and robotic configurations for industrial applications.	PO1	PSO2, PSO3
CO4	Evaluate automated welding systems and robotic welding cells considering productivity, quality and operational requirements and prepare technical reports.	PO1, PO2	PSO2, PSO3
CO5	Develop automated and robotic welding solutions for industrial fabrication and manufacturing applications.	PO1, PO2, PO3	PSO2, PSO3

The Course Articulation Matrix (CAM) for defined COs

	P01	P02	P03	PS01	PS02
CO1					
CO2			2		3
CO3	3		1		3
CO4	2	3	1		3
CO5	3	2	2		3

Activities:

1.	Activity I (CO4): Technical Poster Presentation on Welding Automation and Robotic Welding Systems
2.	Activity II (CO5): Technical Seminar Presentation on Advanced Robotic Welding Technologies (Independent Study)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content
2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization
3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information
5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Topic Selection & Literature Review	20	Recent and highly relevant topic with good literature support	Relevant topic	Basic topic

2.	Technical Understanding	20	Demonstrates excellent conceptual understanding	Good understanding	Limited understanding
3.	Industrial Applications / Case Study	20	Well-supported with industrial examples and technical discussion	Adequate examples	Few examples
4.	Technical Report Preparation	20	Professional report with proper references and formatting	Good report	Incomplete report
5.	Seminar Presentation & Interaction	20	Excellent presentation, confidence, and response to questions	Good presentation	Poor communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Strength = 3 (if percentage >20%); Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%).

20WTE11	WELDING CODES AND STANDARDS		SEMESTER		III	
Prerequisites		Category	ES(PE)	Credits	3	
Manufacturing Technology		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To provide an overview of welding codes, standards and their importance in fabrication industries.					
2.	To understand structural, piping and pressure vessel codes used in engineering applications.					
3.	To develop knowledge on welding procedure specifications, qualification procedures and inspection requirements.					
4.	To understand material standards, consumable qualification and testing procedures.					
5.	To apply welding codes and standards for quality assurance, safety and regulatory compliance.					
UNIT - I		STRUCTURAL WELDING CODES				9
Introduction to welding codes and standards. Purpose and scope of welding codes. Structural welding code requirements. Design requirements, allowable stress values, workmanship requirements, fabrication practices, inspection requirements and acceptance criteria. Overview of AWS structural welding standards.						
UNIT - II		PETROLEUM PIPING FABRICATION				9
Process and product standards for pipe manufacturing. Welding procedure qualification and welder qualification requirements. Field welding practices and inspection procedures. Introduction to API 1104 and API 5L standards. Welding quality requirements in pipeline fabrication and maintenance.						
UNIT - III		PRESSURE VESSEL FABRICATION				9
Design requirements for pressure vessels. Fabrication methods and joint categories. Welding and inspection requirements. Post Weld Heat Treatment (PWHT). Hydrostatic testing procedures. Introduction to ASME Section VIII requirements for pressure vessel fabrication.						
UNIT - IV		WELDING PROCEDURE AND WELDER QUALIFICATION				9
Welding Procedure Specification (WPS). Procedure Qualification Record (PQR). Welder Performance Qualification (WPQ). Essential, supplementary essential and non-essential variables. Qualification requirements and documentation procedures according to ASME Section IX.						
UNIT - V		MATERIALS AND CONSUMABLES				9
Introduction to material standards and specifications. Mechanical and chemical testing of materials. Welding consumable classification and testing procedures. Consumable qualification requirements as per ASME and AWS standards. Quality assurance and traceability requirements.						
L:45, Total:45 Hours						
Weightage: Continuous Assessment 40% End Semester Examinations 60%						

REFERENCE BOOKS:			
1.	AWS D1.1/D1.1M, <i>Structural Welding Code – Steel</i> , American Welding Society, Latest Edition.		
2.	API Standard 1104, <i>Welding of Pipelines and Related Facilities</i> , American Petroleum Institute, Latest Edition.		
3.	ASME Boiler and Pressure Vessel Code, <i>Section VIII Division 1 – Rules for Construction of Pressure Vessels</i> , Latest Edition.		
4.	ASME Boiler and Pressure Vessel Code, <i>Section IX – Welding, Brazing and Fusing Qualifications</i> , Latest Edition.		
5.	ASME Boiler and Pressure Vessel Code, <i>Section II Parts A & C – Materials and Welding Consumables</i> , Latest Edition.		
6.	API Specification 6A, <i>Specification for Wellhead and Christmas Tree Equipment</i> , Latest Edition.		
7.	Jeffus Larry, <i>Welding Principles and Applications</i> , 9th Edition, Cengage Learning, 2017.		
8.	Cary Howard B. and Helzer Scott C., <i>Modern Welding Technology</i> , 7th Edition, Pearson Education, 2020.		
E-RESOURCES:			
1.	American Welding Society (AWS) Learning Resources.		
2.	American Society of Mechanical Engineers (ASME) Code Resources.		
3.	American Petroleum Institute (API) Standards Portal.		
4.	NPTEL – Welding Technology Courses.		
5.	TWI Knowledge Hub – Welding Standards and Qualification.		
6.	Welding Institute Online Technical Resources.		
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain the significance of welding codes, standards, material specifications and qualification procedures used in fabrication industries.		
CO2	Apply structural welding, pipeline fabrication and pressure vessel code requirements in welding practices.	PO1	PSO2
CO3	Analyze welding procedures, qualification records and inspection requirements based on applicable standards.	PO1	PSO1
CO4	Evaluate compliance of welded structures, pipelines and pressure vessels with relevant codes, standards and quality requirements.	PO2, PO3	PSO1, PSO2
CO5	Develop welding documentation, qualification procedures and quality assurance plans in accordance with industrial standards and regulations.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

	P01	P02	P03	PS01	PS02
CO1					
CO2			2	1	3
CO3	2		1	1	3
CO4	2	3	1		3
CO5	3	3	2		3

Activities:

1.	Activity I (CO4): Technical Poster Presentation on Welding Codes, Standards and Qualification Procedures
2.	Activity II (CO5): Technical Seminar Presentation on Industrial Applications of Welding Codes and Standards (Independent Study)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content
2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization
3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information
5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Topic Selection & Literature Review	20	Recent and highly relevant topic with good literature support	Relevant topic	Basic topic
2.	Technical Understanding	20	Demonstrates excellent conceptual understanding	Good understanding	Limited understanding
3.	Industrial Applications / Case Study	20	Well-supported with industrial examples and technical discussion	Adequate examples	Few examples
4.	Technical Report Preparation	20	Professional report with proper references and formatting	Good report	Incomplete report
5.	Seminar Presentation & Interaction	20	Excellent presentation, confidence, and response to questions	Good presentation	Poor communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Strength = 3 (if percentage >20%); Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%).

26WTE12		ADDITIVE MANUFACTURING			Semester			III
Prerequisites Manufacturing Processes				Category	ES(PE)	Credit		3
				Hours/ Semester	L	T	P	TH
					45	0	0	45
COURSEOBJECTIVES								
1.	To Understand the fundamentals of various Additive Manufacturing Technologies and STL file formations for application to various industrial needs.							
2.	To understand various methods of manufacturing of liquid based, powder based and solid based Additive Manufacturing techniques.							
UNIT- I		INTRODUCTION						9
Prototyping fundamentals, Historical development, Advantages of AMT, Commonly used terms, process chain, 3D modeling, Data Conversion, and transmission, Checking and preparing, Building, Post processing, RP data formats, Classification of AMT process, Applications to various fields.								
UNIT- II		LIQUID BASED SYSTEMS						9
Stereo lithography apparatus (SLA): Models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies. Solid ground curing (SGC): Models and specifications, process, working, principle, applications, advantages and disadvantages, case studies.								
UNIT- III		SOLID BASED SYSTEMS						9
Laminated object manufacturing (LOM): Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Casestudies. Fused Deposition Modeling (FDM): Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Casestudies, practical demonstration.								
UNIT- IV		POWDER BASED SYSTEMS						9
Selective laser sintering (SLS): Models and specifications, process, working principle, applications, advantages and disadvantages, casestudies. Three dimensional printing (3DP): Models and specification, process, working principle, applications, advantages and disadvantages, casestudies.								
UNIT- V		APPLICATION OF ADDITIVE MANUFACTURING						9
Artificial Heart, Prosthetic Cardiac Valves, Artificial lung (oxygenator), Artificial Kidney (Dialyser membrane), Dental Implants, Orthopedic Implants and Biomaterials in Ophthalmology - Aerospace, automobile, Agricultural, Oil and gas industries.								
Total (45L)=45 Hours								
TEXT BOOKS:								
1.	IanGibson, DavinRosen, BrentStucker "Additive Manufacturing Technologies", Springer, 2 nd Ed, 2014.							
2.	ChuaC.K., Leong K.F. and LIMC.S Rapid prototyping: Principles and Applications, World Scientific publications, 3rdEd., 2010							
Weightage: Continuous Assessment 40% End Semester Examinations 60%								
REFERENCEBOOKS:								
1.	D.T.Phamand S.S.Dimov, "Rapid Manufacturing", Springer, 2001							
2.	Paul F.Jacobs, "Rapid Prototyping and Manufacturing", ASME Press, 1996							
3.	Terry Wohlers, "Wohlers Report 2000", Wohlers Associates, 2000.							

E-RESOURCES:					
1.	NPTEL – NPTEL				
2.	MIT OpenCourseWare – MIT OpenCourseWare				
3.	ASTM International – ASTM Additive Manufacturing				
4.	ISO Additive Manufacturing – ISO Additive Manufacturing				
5.	Wohlers Associates – Wohlers Associates				
6.	America Makes – America Makes				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs		
CO1	Explain the fundamentals of additive manufacturing, process classifications, process planning, CAD modelling, data preparation and design considerations for additive manufacturing.				
CO2	Apply liquid-based, solid-based and powder-based additive manufacturing processes for the fabrication of engineering components based on material and application requirements.	PO1	PSO1		
CO3	Analyze the influence of process parameters, material selection, build orientation, support structures and post-processing techniques on the quality and performance of additively manufactured components.	PO1	PSO1, PSO2		
CO4	Evaluate suitable additive manufacturing processes for rapid prototyping, rapid tooling and industrial applications considering technical feasibility, productivity and component quality.	PO2, PO3	PSO2, PSO3		
CO5	Develop engineering solutions using advanced additive manufacturing technologies by integrating process planning, material selection, design optimization and industrial applications.	PO1, PO2, PO3	PSO1, PSO2, PSO3		
The Course Articulation Matrix (CAM) for defined Cos					
	PO1	PO2	PO3	PSO1	PSO2
CO1	–	–	–	–	–
CO2	2	–	–	2	–
CO3	2	–	–	2	1
CO4	–	2	2	–	2
CO5	2	2	2	2	2
Activities:					
1.	Activity 1 (CO4): Technical Poster on Additive Manufacturing Processes				
2.	Activity 2 (CO5): Technical Seminar on Industrial Applications of Additive				

Rubrics for evaluation: CO4**Activity 1 (CO4):** Technical Poster on Additive Manufacturing Processes

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Understanding of AM Process	20	Comprehensive explanation with accurate technical concepts	Adequate explanation with minor omissions	Basic understanding only
2.	Technical Content	20	Detailed process flow, materials and applications	Adequate technical information	Limited technical details
3.	Industrial Applications	20	Appropriate applications with justification	Applications adequately explained	Few applications mentioned
4.	Poster Organization & Creativity	20	Well-organized, attractive and technically informative	Acceptable presentation	Poor organization
5.	Presentation & Technical Discussion	20	Excellent explanation and responses to questions	Good explanation	Limited explanation
	Total	100			

Rubrics for evaluation: CO5**Activity:** Technical Seminar on Industrial Applications of Additive Manufacturing

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Topic Selection & Literature Review	20	Recent and highly relevant topic with good literature support	Relevant topic	Basic topic
2.	Technical Understanding	20	Demonstrates excellent conceptual understanding	Good understanding	Limited understanding
3.	Industrial Applications / Case Study	20	Well-supported with industrial examples and technical discussion	Adequate examples	Few examples
4.	Technical Report Preparation	20	Professional report with proper references and formatting	Good report	Incomplete report
5.	Seminar Presentation & Interaction	20	Excellent presentation, confidence, and response to questions	Good presentation	Poor communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12			12	2
C02	24	24			24	2
C03	24	24			24	2
C04			40		20	3
C05				40	20	3
Total	60	60	40	40	100	

Note: Strength = 3 (if percentage >20%); Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%).

26WTE13	CORROSION AND SURFACE ENGINEERING		SEMESTER		III	
Prerequisites		Category	ES(PE)	Credits	3	
Engineering Materials and Metallurgy		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To understand the mechanisms and forms of corrosion occurring in engineering materials.					
2.	To study corrosion testing methods and corrosion prevention techniques used in industries.					
3.	To analyze the corrosion behavior of metallic and non-metallic engineering materials.					
4.	To understand surface engineering techniques used for wear and corrosion resistance.					
5.	To gain knowledge on advanced thin film coating technologies and their engineering applications.					
UNIT – I	MECHANISMS AND TYPES OF CORROSION					9
Principles of direct chemical corrosion and electrochemical corrosion. Hydrogen evolution and oxygen absorption mechanisms. Galvanic corrosion and galvanic series. Types of corrosion – uniform corrosion, pitting corrosion, intergranular corrosion, cavitation corrosion, crevice corrosion, fretting corrosion, erosion corrosion and stress corrosion cracking. Factors influencing corrosion.						
UNIT - II	TESTING AND PREVENTION OF CORROSION					9
Corrosion testing techniques and procedures. Corrosion testing ASTM standards. Pitting corrosion test. Hydrogen Induced Cracking (HIC) test. Sulphide Stress Corrosion Cracking (SSCC) test. Prevention of corrosion. Design against corrosion. Modification of corrosive environments. Corrosion inhibitors. Cathodic protection. Protective surface coatings.						
UNIT - III	CORROSION BEHAVIOR OF MATERIALS					9
Corrosion behavior of carbon steels, alloy steels and stainless steels. Corrosion of aluminium alloys, copper alloys, nickel alloys and titanium alloys. Corrosion characteristics of polymers, ceramics and composite materials.						
UNIT - IV	SURFACE ENGINEERING FOR WEAR AND CORROSION RESISTANCE					9
Diffusion coatings. Electroplating and electroless plating. Hot dip coatings. Hard facing. Metal spraying. Flame spraying and arc spraying processes. Conversion coatings. Selection of surface coatings for wear resistance and corrosion resistance applications.						
UNIT – V	THIN LAYER ENGINEERING PROCESSES					9
Laser hardening and electron beam hardening. Effect of process variables such as power and scan speed. Physical Vapor Deposition (PVD), thermal evaporation, arc vaporization, sputtering and ion plating. Chemical Vapor Deposition (CVD). Tool coatings including TiC, TiN, Al ₂ O ₃ and diamond coatings. Properties and applications of thin coatings.						
L:45, Total:45 Hours						
Weightage:						
Continuous Assessment 40%						
End Semester Examinations 60%						

REFERENCE BOOKS:	
1.	Fontana M.G., Corrosion Engineering , 3rd Edition, Tata McGraw Hill, 2017.
2.	Jones D.A., Principles and Prevention of Corrosion , 3rd Edition, Pearson Education, 2018.
3.	ASM Handbook Volume 13A, Corrosion: Fundamentals, Testing and Protection , ASM International, 2021.
4.	ASM Handbook Volume 5, Surface Engineering , ASM International, 2018.
5.	Pierre R. Roberge, Handbook of Corrosion Engineering , 2nd Edition, McGraw Hill, 2019.
6.	Burak Akçay and Peter Martin, Surface Engineering and Coatings , Elsevier, 2020.
7.	Sudarshan T.S., Surface Engineering and Tribology , CRC Press, 2019.

E-RESOURCES:	
1.	NPTEL – Corrosion Engineering.
2.	NPTEL – Surface Engineering and Coatings.
3.	ASM International Digital Library.
4.	NACE Corrosion Resources.
5.	TMS Learning Resources on Surface Engineering.

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain corrosion mechanisms, corrosion testing methods, corrosion prevention techniques and surface engineering processes used in engineering applications.	-	-
CO2	Apply corrosion testing procedures, corrosion control methods and surface treatment techniques for engineering materials and welded structures.	PO3	PSO1
CO3	Analyze corrosion behavior of engineering materials and evaluate the effectiveness of corrosion prevention and surface engineering techniques.	PO1	PSO1, PSO2
CO4	Evaluate corrosion failures, coating systems and surface engineering processes for industrial applications and prepare technical reports.	PO1, PO2	PSO1, PSO2
CO5	Develop corrosion mitigation strategies and surface engineering solutions for improving service performance of engineering components and welded structures.	PO1, PO2	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined Cos

	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			2	3	1
CO3	3		1	3	2
CO4	2	3	1	3	2
CO5	3	2	2	3	3

Activities:

1.	Activity I (CO4): Technical Poster Presentation on Corrosion Prevention and Surface Engineering Techniques
2.	Activity II (CO5): Technical Seminar Presentation on Advanced Corrosion Control and Surface Engineering (Independent Study)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content
2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization
3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information
5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Topic Selection & Literature Review	20	Recent and highly relevant topic with good literature support	Relevant topic	Basic topic
2.	Technical Understanding	20	Demonstrates excellent conceptual understanding	Good understanding	Limited understanding
3.	Industrial Applications / Case Study	20	Well-supported with industrial examples and technical discussion	Adequate examples	Few examples
4.	Technical Report Preparation	20	Professional report with proper references and formatting	Good report	Incomplete report

5.	Seminar Presentation & Interaction	20	Excellent presentation, confidence, and response to questions	Good presentation	Poor communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Strength = 3 (if percentage >20%); Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%).

26WTE14	COMPOSITE MATERIALS			SEMESTER		III	
Prerequisites			Category	ES(PE)	Credits	3	
Engineering Materials and Metallurgy			Hours/ Semester	L	T	P	TH
				45	0	0	45
COURSE OBJECTIVES							
1.	To understand the fundamentals, classification and constituent materials of composites.						
2.	To study various reinforcement materials and their influence on composite properties.						
3.	To understand the manufacturing methods and applications of metal matrix, ceramic matrix and carbon-carbon composites.						
4.	To study polymer matrix composite processing techniques and industrial applications.						
5.	To analyze the mechanical behavior and strength characteristics of composite materials.						
UNIT - I		INTRODUCTION TO COMPOSITES					9
Definition, classification and characteristics of composite materials. Advantages and applications of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement size, shape, distribution and volume fraction on overall composite performance.							
UNIT - II		REINFORCEMENTS					9
Preparation, lay-up, curing, properties and applications of glass fibres, carbon fibres, Kevlar fibres and boron fibres. Properties and applications of whiskers and particle reinforcements. Mechanical behaviour of composites. Rule of mixtures, inverse rule of mixtures. Isostrain and isostress conditions.							
UNIT - III		MANUFACTURING OF METAL MATRIX COMPOSITES					9
Manufacturing of Metal Matrix Composites (MMC): Casting, solid-state diffusion techniques, cladding and hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites (CMC): Liquid metal infiltration and liquid phase sintering. Manufacturing of Carbon-Carbon Composites: Knitting, braiding and weaving techniques. Properties and applications.							
UNIT - IV		MANUFACTURING OF POLYMER MATRIX COMPOSITES					9
Preparation of moulding compounds and prepregs. Hand lay-up method. Autoclave method. Filament winding method. Compression moulding. Reaction injection moulding. Properties and applications of polymer matrix composites.							
UNIT - V		STRENGTH OF COMPOSITES					9
Laminar failure criteria. Strength ratio. Maximum stress criterion. Maximum strain criterion. Interactive failure criteria. Hydrothermal failure. Laminate first ply failure. Laminate strength. Ply discount truncated maximum strain criterion. Strength design using carpet plots. Stress concentration in composites.							
L:45, Total:45 Hours							
Weightage: Continuous Assessment 40% End Semester Examinations 60%							

REFERENCE BOOKS:	
1.	Krishan K. Chawla, Composite Materials: Science and Engineering , 4th Edition, Springer, 2019.
2.	Autar K. Kaw, Mechanics of Composite Materials , 3rd Edition, CRC Press, 2021.
3.	Matthews F.L. and Rawlings R.D., Composite Materials: Engineering and Science , Woodhead Publishing, 2017.
4.	Mallick P.K., Fiber Reinforced Composites: Materials, Manufacturing and Design , 4th Edition, CRC Press, 2020.
5.	Daniel I.M. and Ishai O., Engineering Mechanics of Composite Materials , 2nd Edition, Oxford University Press, 2018.
6.	Agarwal B.D., Broutman L.J. and Chandrashekhara K., Analysis and Performance of Fiber Composites , 3rd Edition, Wiley, 2017.
7.	ASM Handbook Volume 21, Composites , ASM International, 2018.

E-RESOURCES:	
1.	NPTEL – Composite Materials.
2.	NPTEL – Mechanics of Composite Materials.
3.	NPTEL – Advanced Composite Materials.
4.	ASM International Composite Materials Resources.
5.	TMS Learning Resources on Composite Materials.

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain the fundamentals, classifications, reinforcement systems, manufacturing processes and mechanical behaviour of composite materials.	-	-
CO2	Apply composite material concepts and manufacturing techniques for engineering applications.	PO3	PSO1
CO3	Analyze reinforcement characteristics, composite processing methods and strength behaviour of composite materials.	PO1	PSO1, PSO3
CO4	Evaluate composite material systems, manufacturing processes and failure criteria for engineering applications and prepare technical reports.	PO1, PO2	PSO1
CO5	Develop suitable composite material solutions and manufacturing methodologies for advanced engineering applications.	PO1, PO2, PO3	PSO1, PSO3

The Course Articulation Matrix (CAM) for defined Cos

	P01	P02	P03	PSO1	PSO2
CO1					
CO2			2	3	
CO3	3		1	3	
CO4	2	3	1	2	
CO5	3	2	2	3	

Activities:

1.	Activity I (CO4): Technical Poster Presentation on Composite Materials and Manufacturing Techniques
2.	Activity II (CO5): Technical Seminar Presentation on Advanced Composite Materials and Industrial Applications (Independent Study)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content
2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization
3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information
5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Topic Selection & Literature Review	20	Recent and highly relevant topic with good literature support	Relevant topic	Basic topic
2.	Technical Understanding	20	Demonstrates excellent conceptual understanding	Good understanding	Limited understanding
3.	Industrial Applications / Case Study	20	Well-supported with industrial examples and technical discussion	Adequate examples	Few examples
4.	Technical Report Preparation	20	Professional report with proper references and formatting	Good report	Incomplete report
5.	Seminar Presentation & Interaction	20	Excellent presentation, confidence, and response to questions	Good presentation	Poor communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Strength = 3 (if percentage >20%); Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%).

26WTE15	NON – METALLIC MATERIALS		SEMESTER		III	
Prerequisites		Category	ES(PE)	Credits		3
Engineering Materials and Metallurgy		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To understand the classification, structure, properties and applications of polymers used in engineering applications.					
2.	To study polymer processing methods and mechanical behavior of polymeric materials.					
3.	To understand the crystal structures, properties and applications of engineering ceramics.					
4.	To study processing techniques of ceramics and glasses used in advanced engineering applications.					
5.	To gain knowledge on polymer matrix and ceramic matrix composites and their manufacturing methods.					
UNIT - I		INTRODUCTION TO POLYMERS				9
Classification of polymers – thermosets, thermoplastics and elastomers. Structure of polymers – crystalline and amorphous polymers. Concept of Glass Transition Temperature (T _g). Polymerization – types and mechanisms with examples. Degree of polymerization. Molecular weight of polymers and numerical problems. Polymer additives. Structure, properties and applications of polyethylene, polypropylene, polyvinyl chloride, polystyrene, polymethyl methacrylate, PTFE, polyamides, polyesters, polycarbonates and polyurethanes. Engineering rubbers, natural rubber, styrene butadiene rubber and nitrile rubbers.						
UNIT - II		PROCESSING AND BEHAVIOUR OF POLYMERS				9
Equipment and process details of extrusion, injection moulding, reaction injection moulding, reinforced reaction injection moulding, thermoforming, blow moulding, compression moulding and calendaring. Viscoelasticity, creep and stress relaxation in polymers. Yielding and fracture of polymers. Crazing of polymers.						
UNIT - III		ENGINEERING CERAMICS				9
Review of bonding types in ceramics. Calculation of percentage ionic character. Ceramic crystal structures – sodium chloride, cesium chloride, alumina, spinel and fluorite structures. Coordination number and ionic radius ratio. Pauling’s rules. Numerical problems involving packing factor, critical radius ratio and density. Properties and applications of silicon carbide, cubic boron nitride, partially stabilized zirconia, barium titanate and iron ferrites.						
UNIT - IV		PROCESSING OF CERAMICS AND GLASSES				9
Slip casting and slurry casting processes and applications. Powder processing equipment. Hot pressing, hot isostatic pressing and cold isostatic pressing. Liquid phase sintering. Types of glasses, structure, properties and applications. Glass manufacturing processes – blowing, pressing, drawing, rolling and casting. Pilkington process for float glass manufacturing.						
UNIT - V		COMPOSITES				9
Polymer Matrix Composites (PMC) Polymer matrix resins. Reinforcement fibres and their types. PMC manufacturing processes – hand lay-up, spray-up, compression moulding, resin transfer moulding, pultrusion and injection moulding. Fiber reinforced plastics (FRP) and glass fiber reinforced plastics (GRP). Ceramic Matrix Composites (CMC) Ceramic matrices – oxide ceramics and non-oxide ceramics. Alumina and silicon nitride ceramics. Reinforcements – particles, fibres and whiskers. Processing methods – sintering, hot pressing, cold isostatic pressing and hot isostatic pressing.						
L:45, Total:45 Hours						

Weightage: Continuous Assessment 40% End Semester Examinations 60%			
REFERENCE BOOKS:			
1.	Callister W.D. and Rethwisch D.G., Materials Science and Engineering: An Introduction , 11 th Edition, Wiley India, 2023.		
2.	V. Raghavan, Materials Science and Engineering , 7th Edition, PHI Learning, 2022.		
3.	Billmeyer F.W., Textbook of Polymer Science , 3rd Edition, Wiley India, Reprint 2019.		
4.	Fried J.R., Polymer Science and Technology , 4th Edition, Pearson Education, 2021.		
5.	Barsoum M.W., Fundamentals of Ceramics , 2nd Edition, CRC Press, 2019.		
6.	Reed J.S., Principles of Ceramics Processing , 2nd Edition, Wiley, 2018.		
7.	Krishan K. Chawla, Composite Materials: Science and Engineering , 4th Edition, Springer, 2019.		
E-RESOURCES:			
1.	NPTEL – Polymer Science and Engineering.		
2.	NPTEL – Engineering Ceramics.		
3.	NPTEL – Composite Materials.		
4.	ASM International Materials Database.		
5.	Ceramic Materials Foundation Learning Resources.		
6.	Polymer Processing and Applications NPTEL Modules.		
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain the structure, classification, processing methods and properties of polymers, ceramics, glasses and composite materials.	-	-
CO2	Apply concepts of polymer science, ceramic engineering and composite materials for engineering applications.	PO3	PSO1
CO3	Analyze the relationship between structure, processing and properties of polymers, ceramics and composites.	PO1	PSO1
CO4	Evaluate processing techniques, material performance and application suitability of non-metallic materials and prepare technical reports.	PO1, PO2	PSO1, PSO2
CO5	Develop material selection and processing strategies involving polymers, ceramics and composites for engineering applications.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

	P01	P02	P03	PS01	PS02
CO1					
CO2			2	3	1
CO3	3		1	3	
CO4	2	3	1	2	2
CO5	3	2	2	3	2

Activities:

1.	Activity I (CO4): Technical Poster Presentation on Non-Metallic Materials and Their Engineering Applications
2.	Technical Seminar Presentation on Recent Developments in Non-Metallic Materials (Independent Study)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content
2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization
3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information
5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Topic Selection & Literature Review	20	Recent and highly relevant topic with good literature support	Relevant topic	Basic topic
2.	Technical Understanding	20	Demonstrates excellent conceptual understanding	Good understanding	Limited understanding

3.	Industrial Applications / Case Study	20	Well-supported with industrial examples and technical discussion	Adequate examples	Few examples
4.	Technical Report Preparation	20	Professional report with proper references and formatting	Good report	Incomplete report
5.	Seminar Presentation & Interaction	20	Excellent presentation, confidence, and response to questions	Good presentation	Poor communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	2
CO3	24	24			24	2
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Strength = 3 (if percentage >20%); Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%).

26WTE16	FAILURE ANALYSIS IN WELDMENTS			SEMESTER		III		
Prerequisites				Category	ES(PE)	Credits	3	
Engineering Materials and Metallurgy				Hours/ Semester	L	T	P	TH
					45	0	0	45
COURSE OBJECTIVES								
1.	To understand the principles and methodology of failure analysis in welded components.							
2.	To study fracture mechanisms, corrosion failures and wear-related failures in weldments.							
3.	To analyze fatigue, creep and environmentally assisted failures occurring in welded structures.							
4.	To understand failure modes in welded products and techniques for failure investigation.							
5.	To develop reliability concepts and life prediction methods for welded systems and components.							
UNIT - I		INTRODUCTION TO FAILURE ANALYSIS						9
Stages of failure analysis. Classification and identification of various types of fracture. Overview of fracture mechanics. Characteristics of ductile fracture and brittle fracture. Fractographic examination and interpretation of fracture surfaces								
UNIT - II		WELDMENT SURFACE FAILURES						9
Types of wear and analysis of wear failures. Corrosion failures and factors influencing corrosion failures. Overview of corrosion mechanisms. Stress corrosion cracking – sources, characteristics and mechanisms. Procedure for analyzing stress corrosion cracking failures. Hydrogen damage failures and their characteristics.								
UNIT - III		WELDMENT CREEP AND FATIGUE FAILURES						9
General concepts of fatigue and creep failures. Fracture characteristics revealed through microscopy. Factors affecting fatigue life. Creep, stress rupture, elevated temperature fatigue. Metallurgical instabilities. Environmentally induced failures. Case studies on weldment failures.								
UNIT - IV		FAILURE OF WELDED PRODUCTS						9
Causes of failure in forge weldments. Failure of welded iron and steel castings. Failures due to improper heat treatment of weldments. Stress concentration effects in weldments. In-service weldment failures. Procedure for weld failure analysis and data extraction.								
UNIT - V		RELIABILITY						9
Reliability concepts and hazard functions. Life prediction methodologies. Condition monitoring techniques. Application of Poisson, exponential and Weibull distributions for reliability analysis. Bathtub curve. Parallel and series systems. Mean Time Between Failures (MTBF) and life testing.								
L:45, Total:45 Hours								
Weightage:								
Continuous Assessment 40%								
End Semester Examinations 60%								

REFERENCE BOOKS:					
1.	ASM Handbook Volume 11, Failure Analysis and Prevention , ASM International, 2018.				
2.	Donald J. Wulpi, Understanding How Components Fail , 3rd Edition, ASM International, 2013.				
3.	Das A.K., Metallurgy of Failure Analysis , Tata McGraw Hill, New Delhi, 2018.				
4.	Colangelo V.J. and Heiser F.A., Analysis of Metallurgical Failures , 3rd Edition, Wiley, 2019.				
5.	Dieter G.E., Mechanical Metallurgy , 3rd Edition, McGraw Hill, Reprint 2017.				
6.	Norman E. Dowling, Mechanical Behavior of Materials , 5th Edition, Pearson, 2020.				
7.	R.S. Parmar, Welding Engineering and Technology , 3rd Edition, Khanna Publishers, 2020.				
E-RESOURCES:					
1.	NPTEL – Failure Analysis of Engineering Materials.				
2.	NPTEL – Fracture Mechanics.				
3.	NPTEL – Reliability Engineering.				
4.	ASM International Failure Analysis Resources.				
5.	TMS Failure Analysis Learning Modules.				
6.	American Welding Society (AWS) Technical Resources.				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs		
CO1	Explain failure analysis methodologies, fracture mechanisms, corrosion failures, fatigue failures and reliability concepts related to weldments.	-	-		
CO2	Apply failure analysis procedures and reliability concepts for evaluating weldment failures under service conditions.	PO3	PSO1		
CO3	Analyze wear, corrosion, fatigue, creep and fracture failures occurring in welded components and structures.	PO1	PSO1, PSO3		
CO4	Evaluate failure mechanisms, fracture evidence and reliability data to identify root causes of weldment failures and prepare technical reports.	PO1, PO2	PSO1, PSO2		
CO5	Develop failure prevention strategies, life prediction approaches and reliability improvement methodologies for welded products and structures.	PO1, PO2, PO3	PSO1, PSO2, PSO3		
The Course Articulation Matrix (CAM) for defined COs					
	PO1	PO2	PO3	PSO1	PSO2
CO1					
CO2			2	3	1
CO3	3		1	3	
CO4	2	3	1	3	2
CO5	3	2	2	3	2

Activities:

1.	Activity I (CO4): Technical Poster Presentation on Failure Analysis of Welded Components
2.	Activity II (CO5): Technical Seminar Presentation on Case Studies in Failure Analysis of Weldments (Independent Study)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Technical Content	20	Comprehensive coverage of engineering materials and heat treatment concepts	Adequate coverage	Limited content
2.	Poster Organization & Visual Presentation	20	Well-organized, attractive and easy to understand	Moderately organized	Poor organization
3.	Technical Analysis & Industrial Relevance	20	Clear analysis with appropriate industrial applications	Partial analysis	Limited analysis
4.	Innovation & Recent Developments	20	Includes recent developments with good interpretation	Adequate discussion	Minimal information
5.	Presentation & Discussion	20	Excellent explanation and responses to questions	Good explanation	Poor communication
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Topic Selection & Literature Review	20	Recent and highly relevant topic with good literature support	Relevant topic	Basic topic
2.	Technical Understanding	20	Demonstrates excellent conceptual understanding	Good understanding	Limited understanding
3.	Industrial Applications / Case Study	20	Well-supported with industrial examples and technical discussion	Adequate examples	Few examples
4.	Technical Report Preparation	20	Professional report with proper references and formatting	Good report	Incomplete report

5.	Seminar Presentation & Interaction	20	Excellent presentation, confidence, and response to questions	Good presentation	Poor communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12			12	2
C02	24	24			24	2
C03	24	24			24	2
C04			40		20	3
C05				40	20	3
Total	60	60	40	40	100	

Note: Strength = 3 (if percentage >20%); Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%).

26AC001	ENGLISH FOR RESEARCH PAPER WRITING M.E. (Common to all Branches)			SEMESTER		I/II
Prerequisites			Category	AC	Credits	
Basic proficiency in English and familiarity with academic and technical writing.			Hours/ Semester	L	T	P
				30	0	0
0						
COURSE OBJECTIVES						
1.	To develop awareness of the importance of English in academic and research communication.					
2.	To familiarize learners with the structure and organization of research papers.					
3.	To improve learners' ability to use appropriate academic language and expressions in research writing.					
4.	To help learners avoid common language errors and improve the quality of their research papers.					
5.	To enable learners to write and present research work using accepted academic conventions.					
UNIT - I						
FUNDAMENTALS OF RESEARCH AND ACADEMIC WRITING			6			
Research and its significance. Purpose, characteristics, and structure of a research paper. Types of research publications. Identifying research problems and defining objectives. Features of academic English, including formal and objective style. Academic vocabulary, clear and concise sentence construction, and avoidance of redundancy and common grammatical errors. Selection of appropriate journals and conferences for publication.						
UNIT - II			6			
Common phrases for introducing research problems, stating objectives, describing methods, and presenting results. Use of active and passive voice. Appropriate tense forms in research writing. Cohesion and coherence through linking words and transitions.						
UNIT - III			6			
Hedging in academic writing. Paraphrasing and summarizing techniques. Plagiarism and ethical writing practices. Identifying and correcting common language mistakes. Editing and proof reading strategies.						
UNIT - IV			6			
Purpose and structure of review articles. Review of Literature (RoL): literature search, synthesis of findings, and identification of research gaps. Citation practices and avoidance of plagiarism. Practical exercises in organizing literature and drafting literature review sections.						
UNIT - V			6			
Writing effective titles, abstracts, introductions and conclusions. Presenting findings and discussions clearly. Language for oral presentation of research. Useful phrase banks for different sections of a research paper and research presentations.						
L:30, Total:30 Hours						
Weightage: Continuous Assessment - 100%						

REFERENCE BOOKS:

1.	Wallwork, Adrian. English for Writing Research Papers. 3 rd ed., Springer, 2023.
2.	Swales, John M., and Christine B. Feak. Academic Writing for Graduate Students: Essential Tasks and Skills. 4 th ed., University of Michigan Press, 2020.
3.	Glasman-Deal, Hilary. Science Research Writing for Non-Native Speakers of English. 2 nd ed., Imperial College Press, 2020.
4.	Cargill, Margaret, and Patrick O'Connor. Writing Scientific Research Articles: Strategy and Steps. 3 rd ed., Wiley-Blackwell, 2021.
5.	Day, Robert A., Barbara Gastel, and Michelle Prince. How to Write and Publish a Scientific Paper. 9 th ed., Greenwood, 2022.

E-RESOURCES:

1.	Author Academy – https://authoracademy.springernature.com
2.	Researcher Academy – https://researcheracademy.elsevier.com
3.	Learn English (British Council) - https://learnenglish.britishcouncil.org/skills/writing
4.	Academic Phrase bank – https://www.phrasebank.manchester.ac.uk
5.	Committee on Publication Ethics (COPE) – https://publicationethics.org

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain the significance of research communication and describe the structure, purpose, and types of research publications.	PO1, PO2	
CO2	Apply appropriate academic vocabulary, sentence structures, and language conventions in research writing.	PO1, PO2	
CO3	Use academic language patterns, cohesive devices, and appropriate grammatical structures to communicate research ideas effectively.	PO1, PO2	
CO4	Analyze research papers to identify writing styles, language patterns, and common grammatical error	PO1, PO2	
CO5	Demonstrate ethical research writing practices through effective paraphrasing, citation, referencing, and avoidance of plagiarism.	PO1, PO2	

The Course Articulation Matrix (CAM) for defined COs

	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2			
CO2	3	3			
CO3	2	3			
CO4	2	3			
CO5	3	3			

Activities:

1.	(i) Assignment 1: Research Paper Analysis and Language Evaluation Select a published research paper from your discipline and analyze its structure, purpose, and major components. Evaluate the use of academic vocabulary, sentence structures, language patterns, cohesive devices, and grammatical conventions. Comment on the effectiveness of the writing and identify areas for improvement. (ii) Assignment 2: Academic Rewriting and Editing Choose a technical text or an excerpt from a research article and revise it using appropriate academic vocabulary, formal style, cohesive devices, and correct grammatical structures. Explain the revisions made and discuss how they improve the quality and clarity of research communication. (iii) Assignment 3: Review of Literature and Research Gap Identification Select a research topic related to your specialization and review at least five recent research articles. Summarize the major findings using appropriate academic language and transitions, compare the studies, identify research gaps, and present the review in a coherent academic format. (iv) Assignment 4: Analysis of Research Writing Conventions Analyze two published research papers from your discipline and compare their writing conventions, language patterns, organization, and presentation of research findings. Examine the use of academic expressions, cohesion, citation practices, and ethical writing principles. Suggest improvements where necessary.
2.	PRESENTATION: (i) Presentation 1: Ethical Issues in Research Writing Discuss plagiarism, self-plagiarism, authorship issues, citation ethics, and the responsibilities of researchers in academic publishing. Illustrate the discussion with examples from published research articles and explain strategies for maintaining academic integrity. (ii) Presentation 2: Paraphrasing, Citation, and Referencing in Research Writing Present effective techniques for paraphrasing and summarizing research literature. Demonstrate the use of citation and referencing styles commonly adopted in academic publications and discuss methods for avoiding plagiarism. (iii) Presentation 3: Review of Literature and Research Gap Identification Select a research topic from your area of specialization and present a brief review of relevant literature. Summarize key findings from published studies, compare their contributions, identify research gaps, and explain how ethical citation practices are followed in the review process. (iv) Presentation 4: Presenting Research Paper Sections Prepare and present the title, abstract, introduction, methodology, findings, and conclusion of a selected research paper. Highlight the language conventions, organization, and presentation strategies used for effective research communication. (v) Presentation 5: Research Conference and Poster Presentation Design and deliver a short conference-style or poster presentation based on a research article or review paper. Demonstrate effective presentation techniques, audience engagement, response to questions, and adherence to ethical practices in reporting and acknowledging sources.

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Understanding and Application of Concepts	25	Shows excellent understanding of the topic	Shows good understanding with minor gaps	Shows basic understanding with several gaps

2.	Analysis and Critical Observation	25	Presents clear and relevant analysis	Adequate analysis with minor omissions	Limited analysis and observations
3.	Organization, Clarity and Coherence	25	Well-organized and easy to follow	Generally organized with minor issues	Organization is weak or inconsistent
4.	Academic Language and Accuracy	25	Accurate academic language with minimal errors	Few language errors that do not affect clarity	Frequent language errors but meaning is understandable
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Assignment	Presentation	Percentage allocation	Mapping Strength
CO1	25		12.5	2
CO2	25		12.5	2
CO3	25		12.5	2
CO4	25		12.5	2
CO5		50	50	3
Total	100	100	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26AC002		DISASTER MANAGEMENT		SEMESTER		I/II	
Prerequisites			Category	AC	Credits		0
			Hours/ Semester	L	T	P	TH
				30	0	0	30
COURSE OBJECTIVES							
1.	To have a critical understanding of key concepts in disaster risk reduction and humanitarian response and critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations and evaluate the strengths and weaknesses of disaster management approaches. Planning and programming in different countries, particularly their home country or the countries they work in.						
UNIT - I		INTRODUCTION					6
Disaster: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude. Disaster Prone Areas in India: Study of Seismic Zones; Area Prone to floods and droughts, Landslides and avalanches; Areas prone to cyclonic and coastal hazards with special reference to Tsunami; Post- Disaster diseases and epidemics.							
UNIT - II		REPERCUSSIONS OF DISASTERS AND HAZARDS					6
Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.							
UNIT - III		DISASTER PREPAREDNESS AND MANAGEMENT					6
Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.							
UNIT - IV		RISK ASSESSMENT					6
Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People’s Participation in Risk Assessment. Strategies for Survival.							
UNIT - V		DISASTER MITIGATION					6
Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.							
L: 30, Total: 30 Hours							
Weightage:							
Continuous Assessment - 100%							

REFERENCE BOOKS:

- | | |
|----|---|
| 1. | R. Nishith, Singh AK 2012 Disaster Management in India: Perspectives, issues and strategies New Royal Book Company, Lucknow |
| 2. | Sahni, PardeepEt.Al. (Eds.) 2002 Disaster Mitigation Experiences and Reflections. Prentice Hall Of India, New Delhi |

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs****CO1**

Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO2

Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO3

develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations

CO4

Critically understand the strengths and weaknesses of disaster management approaches

26AC003	SANSKRIT FOR TECHNICAL KNOWLEDGE			SEMESTER		I/II	
Prerequisites			Category	AC	Credits		0
			Hours/ Semester	L	T	P	TH
				30	0	0	30
COURSE OBJECTIVES							
1.	To get a working knowledge in illustrious Sanskrit, the scientific language in the world. Learning Sanskrit to improve brain functioning. Learning Sanskrit to develop logic in mathematics, science & other subjects enhances the memory power. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature.						
UNIT - I	ALPHABETS						10
Alphabets in Sanskrit –Past/Present/Future Tense –Simple Sentences							
UNIT - II	LITERATURE						10
Order –Introduction of roots –Technical information about Sanskrit Literature							
UNIT - III	CONCEPTS						10
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics							
L: 30, Total: 30 Hours							
Weightage: Continuous Assessment - 100%							
REFERENCE BOOKS:							
1.	"AbhyasaPustakam"- Dr.Vishwas, Samskrita- Bharati Publication, New Delhi						
2.	"Tech Yourself Sanskrit" PrathamaDeeksha-Vempatikutumbshastri,Rashtriya Sanskrit Sansthan, New Delhi Publication						
3.	India’s Glorious Scientific Tradition” Suresh Soni, Ocean books (P) Ltd., New Delhi.						
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs		Mapping PSOs	
CO1	Understanding basic Sanskrit language.						
CO2	Ancient Sanskrit literature about science & technology can be understood.						
CO3	Being a logical language will help to develop logic in students						

26AC004		VALUE EDUCATION		SEMESTER		I/II	
Prerequisites			Category	AC	Credits		0
			Hours/ Semester	L	T	P	TH
				30	0	0	30
COURSE OBJECTIVES							
1.	To understand the Importance of value education and self-development. To imbibe good values in students and also know about the importance of character.						
UNIT - I		BASIC VALUES					7
Values and self-development- Social values and individual attitudes-Work ethics, Indian vision of Humanism Moral and Non Moralvaluation-Standards and principles-Value judgments.							
UNIT - II		CONFIDENCE					7
Importance of cultivation of values- Sense of Duty-Devotion-Self-reliance-Confidence-Concentration-Truthfulness-CleanlinesHonesty-Humanity-Power of faith-National Unity-Patriotism-Love for nature-Discipline.							
UNIT - III		PERSONALITY DEVELOPMENT					8
Personality and Behavior Development-Soul and Scientific attitude - Positive – Thinking - Integrity and discipline -Punctuality – Love and Kindness - Avoid fault Thinking - Free from anger - Dignity of labor - Universal brotherhood and religious tolerance –True friendship –Happiness Vs. suffering –love for truth – Aware of self-destructive habits- Association and Cooperation –Doing best for saving nature.							
UNIT - IV		LOVE AND COMPASSION					8
Character and Competence –Holy books Vs. Blind faith –Self –management and Good health – Science of reincarnation –Equality – Non Violence –Humility -Role of Women –All religions and same message –Mind your Mind –Self -control –Honesty –Studying effectively.							
L: 30, Total: 30 Hours							
Weightage: Continuous Assessment - 100%							
REFERENCE BOOKS:							
1.	Chakraborty, S.K. "Values and Ethics for Organization Theory and Practice", Oxford University Press, New Delhi, 1998.						
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs		Mapping PSOs	
CO1	Knowledge of self-development.						
CO2	Learn the importance of Human values.						
CO3	Developing the overall personality.						

26AC005		CONSTITUTION OF INDIA		SEMESTER		I/II	
Prerequisites			Category	AC	Credits		0
			Hours/ Semester	L	T	P	TH
				30	0	0	30
COURSE OBJECTIVES							
1.	Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.						
UNIT - I		HISTORY OF MAKING OF INDIAN CONSTITUTION					5
History, Drafting Committee (Composition & working)							
UNIT - II		PHILOSOPHY OF THE INDIAN CONSTITUTION					5
Preamble, Salient Features							
UNIT - III		CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES					5
Fundamental rights, right to equality, right to freedom, right against exploitation, right to freedom of religion, cultural and education rights, right to constitutional remedies, directive principles of state policy, fundamental duties.							
UNIT - IV		ORGANS OF GOVERNANCE					5
Parliament, composition, qualifications and disqualifications, powers and functions, executive, president, governor, council of ministers, judiciary, appointment and transfer of judges, qualifications, powers and functions.							
UNIT - V		LOCAL ADMINISTRATION					5
Districts administration head: role and importance, municipalities: introduction, mayor and role of elected representative, CEO of municipal corporation. Panchayati raj: introduction, PRI: zila panchayat. Elected officials and their roles, CEO zila panchayat: position and role. Block level: organizational hierarchy (different departments), village level: role of elected and appointed officials, importance of grass root democracy.							
UNIT - VI		ELECTION COMMISSION					5
Election Commission: role and functioning. Chief election commissioner and election commissioners. State election commission: role and functioning. Institute and bodies for the welfare of SC/ST/OBC and women.							
L: 30, Total: 30 Hours							
Weightage:							
Continuous Assessment - 100%							
REFERENCE BOOKS:							
1.	The Constitution of India, 1950 (Bare Act), Government Publication						
2.	Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.						
3.	M. P. Jain, Indian Constitution Law, 7th Edn., LexisNexis, 2014.						
4.	D.D. Basu, Introduction to the Constitution of India, LexisNexis, 2015						

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics		
CO2	Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.		
CO3	Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution		
CO4	Discuss the passage of the Hindu Code Bill of 1956		

26AC006		PEDAGOGY STUDIES			SEMESTER		I/II	
Prerequisites				Category	AC	Credits		0
				Hours/ Semester	L	T	P	TH
					30	0	0	30
COURSE OBJECTIVES								
1.	To Review existing evidence on the review topic to inform programme design and policy making undertaken by the DFID, other agencies and researchers. Identify critical evidence gaps to guide the development.							
UNIT - I		INTRODUCTION AND METHODOLOGY						6
Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions, Overview of methodology and Searching								
UNIT - II		THEMATIC OVERVIEW						6
Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.								
UNIT - III		EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES						6
Methodology for the in depth stage: quality assessment of included studies, How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices, Pedagogic theory and pedagogical approaches, Teachers' attitudes and beliefs and Pedagogic strategies.								
UNIT - IV		PROFESSIONAL DEVELOPMENT						6
Alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning: limited resources and large class sizes.								
UNIT - V		RESEARCH GAPS AND FUTURE DIRECTIONS						6
Research design, Contexts, pedagogy, teacher education, curriculum and assessment, dissemination and research impact.								
L: 30, Total: 30 Hours								
Weightage: Continuous Assessment - 100%								

REFERENCE BOOKS:			
1.	Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.		
2.	Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3) 361-379.		
3.	Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID		
4.	Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic math and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272-282.		
5.	Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.		
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?		
CO2	What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?		
CO3	How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?		

26AC007		STRESS MANAGEMENT BY YOGA			SEMESTER		I/II	
Prerequisites				Category	AC	Credits		0
				Hours/ Semester	L	T	P	TH
					30	0	0	30
COURSE OBJECTIVES								
1.	To create a healthy, strong willed and intelligent young society through yoga practices							
UNIT - I		PHYSICAL AND MENTAL HEALTH						6
Pain and disease - free life, Simplified Physical Exercise- Pranayama. Concentration on Pituitary gland- Practical, Goal fixing								
UNIT - II		REJUVENATION OF LIFE FORCE AND WILL POWER						6
Principle of kayakalpa yoga, mind, life force and Biomagnetism, Practical, Concentration on Muladhara- Practical, Analysis of thought –Will power								
UNIT - III		DEVELOPMENT OF VIRTUES						6
Activation of Dormant Brain cells- Practical, Moralization of dezire and its classification, Neutralization of Anger, Results of anger								
UNIT - IV		STREAM LINING OF MIND						6
Definition of Mind-Worries, Eradication of Worries. The science behind blessings. Blessing techniques. Benefits, five basic duties								
UNIT - V		CAUSE AND EFFECT SYSTEM						6
Law of nature, Hereditary Imprints, Fivefold and Two-fold culture, good values and Resolution for world peace								
L: 30, Total: 30 Hours								
Weightage: Continuous Assessment - 100%								
REFERENCE BOOKS:								
1.	"Thirukkural" , Pearls of Inspiration, Translation by Rajaram, Publisher :RUPA							
2.	"Bharathiyar Poems", Amazon Asia – Pacific Holdings Private Limited							
3.	"Yoga for Humane Excellence" ,Vethathiri Maharishi, Vision for Wisdom, Vethathiri Publications							
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to					Mapping POs		Mapping PSOs	
CO1	Maintain good Physical health.							
CO2	Develop will power.							
CO3	Take quick and right decisions.							
CO4	Maintain good relationship with everyone around them his creating a Health Society							

26AC008	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS			SEMESTER		I/II	
Prerequisites			Category	AC	Credits		0
			Hours/ Semester	L	T	P	TH
				30	0	0	30
COURSE OBJECTIVES							
1.	To learn to achieve the highest goal happily,						
2.	To become a person with stable mind, pleasing personality and determination,						
3.	To awaken wisdom in students.						
UNIT - I	NEETISATAKAM – HOLISTICS DEVELOPMENT OF PERSONALITY						6
Verses 19, 20, 21, 22 (Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)							
UNIT - II	NEETISATAKAM — HOLISTIC DEVELOPMENT OF PERSONALITY (CONT'D)						6
Verses 52, 53, 59 (don'ts) - Verses 71.73.75 & 78 (do's) - Approach to day to day works and duties.							
UNIT - III	INTRODUCTION TO BHAGAVADGEETHA FOR PERSONALITY DEVELOPMENT						6
Shrimad Bhagavadgeetha: Chapter 2 — Verses 41, 47, 48 - Chapter 3 — Verses 13,21,27,35 - Chapter 6 - Verses 5,13,17,23,35 - Chapter 18 - Verses 45,40,48 Chapter - 6: Verses 5, 13, 17, 23, 35; Chapter - 18: Verses 45, 46, 48							
UNIT - IV	STATEMENTS OF BASIC KNOWLEDGE - SHRIMAD BHAGAVADGEETHA						6
Chapter 2- Verses 56, 62,68 - Chapter 12 — Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from Shrimad Bhagawat Geeta.							
UNIT - V	ROLE OF BHAGAVADGEETHA IN THE PRESENT SCENARIO						6
Chapter 2 — Verses 17 - Chapter 3 — Verses 36, 37, 42 - Chapter 4 — Verses 18, 38, 39 - Chapter 18 — Verses 37, 38, 63.							
L: 30, Total: 30 Hours							
Weightage: Continuous Assessment - 100%							
REFERENCE BOOKS:							
1.	“Srimad Bhagavad Gita” by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata						
2.	Bhartrihari’s Three Sataskam (Niti- Sringar – Vairagya), P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.						

E-RESOURCES:			
1.	NTPEL: http://nptel.ac.in/downloads/109104115		
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
C01	Develop their personality and achieve their highest goal of life.		
C02	Lead the nation and mankind to peace and prosperity.		
C03	Practice emotional self-regulation.		
C04	Develop a positive approach to work and duties.		
C05	Develop a versatile personality.		

26AC009	SUSTAINABLE DEVELOPMENT GOALS		SEMESTER			I/II
PREREQUISITES		Category	AC	Credits		0
		Hours/ Semester	L	T	P	TCP
			30	0	0	30
COURSE OBJECTIVES						
1.	To understand the concepts of Sustainable Development Goals					
2.	To study sustainability assessment methods, education for sustainable development					
3.	To analyze the problems and solution in environmental management.					
4.	To analyze the issues related to resource utilization.					
5.	To explore knowledge about life cycle assessment.					
UNIT - I	INTRODUCTION TO SUSTAINABLE DEVELOPMENT					6
Need and Importance of Sustainable Development - Historical & Policy perspectives of Sustainable Development - Sustainable Development: World and India Perspective - Introduction to 17 SDGs - Specific learning objectives for different SDGs - Challenges & strategies of attaining SDGs in developed and developing nations.						
UNIT - II	SDG QUALITY EDUCATION					6
Focus of NEP-2020 on SDG - Education for Sustainable Development - Berlin Declaration 2021 on ESD - Integration of ESD - Tools, Systems, and Innovation for Sustainability - Measuring Sustainability.						
UNIT - III	SUSTAINABLE COMMUNITIES AND RESOURCE CONSERVATION					6
Circular economy (basic model of reuse, recycle, and reduce) - Rural & urban Problems & Challenges - Sustainable production and consumption - Renewable energy - Health & Hygiene, water, sanitation & water management - Waste Management.						
UNIT - IV	CLIMATE CHANGE, ENERGY AND SUSTAINABLE DEVELOPMENT					6
The greenhouse effect: Causes and Consequences - Climate Change: A Threat to Sustainable Development - Adaptation to Current and Future Climate Regimes - Consequences: crop failure - Solutions technology and lifestyle changes - Mitigating Climate Change.						
UNIT - V	SUSTAINABLE BUSINESS PRACTICES					6
Corporate Social Responsibility - Sustainable products and services - Business and Environment - Corporations and Ecological Sustainability - Life Cycle Assessment: LCA Overview and Application - World peace and justice: United nations goals for peace and justice - World Government for peace.						
L:30, Total:30 Hours						
Weightage:						
Continuous Assessment - 100%						

REFERENCE BOOKS:	
1.	Onyeka Osuji, "Corporate Social Responsibility in Developing and Emerging Markets", Cambridge, 2022.
2.	Ram Kumar, Ch Lakshmi, Sandee, Janaki, "Smart Cities for Sustainable Development", Springer Switzerland, 2022.
3.	Surender Kumar and Shunsuke Managi, "The Economics of Sustainable Development: The Case of India (Natural Resource Management and Policy)", Springer Switzerland, 2009.
4.	Sushma Goyal, "Management of Resources for Sustainable Devpt", The Orient Blackswan, 2016.
5.	S. Ramaswamy Sathis G. Kumar, "Energy, Environment and Sustainable Development: Issues and Policies", Regal Publications, 2009.
E-RESOURCES:	
1.	https://www.un.org/sustainabledevelopment/
2.	https://www.aiu.ac.in/documents/AIU_Publications/UN-SDG goals
3.	https://www.unesco.org/en/education-sustainable-development
4.	https://onlinecourses.nptel.ac.in/noc23_hs57/preview
5.	https://www.iau-hesd.net/news/5180-berlin-declaration-education-sustainable development-adopted-unesco-esd-conference-17-19
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to	
CO1	Explain the concepts of Sustainable Development and United Nations Sustainable Development Goals (SDGs), sustainability assessment methods, and their significance in national and global contexts.
CO2	Apply the challenges related to resource utilization, circular economy, renewable energy, sustainable production and consumption, environmental management, climate change, and their impact on society and sustainable development.
CO3	Analyze the sustainable business practices, corporate social responsibility, ecological sustainability, life cycle assessment, and global initiatives for achieving environmental protection, social equity, peace, and sustainable growth.
CO4	Design and develop a sustainability assessment project, case study, field survey, or community-based solution for a selected SDG.
CO5	Demonstrate professional competency through technical seminar presentations/group discussions, or preparation of technical reports on emerging trends, innovations, policies, and best practices related to SDG.