GOVERNMENT COLLEGE OF ENGINEERING
SALEM - 636 011
(An Autonomous Institution Affiliated to Anna University, Chennai)

REGULATIONS 2022
CURRICULUM AND SYLLABUS
(For Candidates admitted from 2022 - 2023 onwards)

M.E – WELDING TECHNOLOGY
(FULL TIME PROGRAMME)

M.E WELDING TECHNOLOGY (FULL TIME)

VISION

To become a globally competent department in Metallurgical and Materials Engineering.

MISSION

- To achieve the vision, our diligent faculty will use effective, continually updated methodologies.
- To mould metallurgical and materials engineering graduates with professional excellence and social responsibility.
- To carry out quality research of national global relevance.
- To provide highest quality technical support and knowledge to industries.

At the end of the course, the welding technology post graduates are,

PEO1. Expand their knowledge of the fundamental theory of the process, design, materials and testing aspects of welding and welding related fields.

PEO2. Practice and establish welding knowledge in an integrated fashion to solve diverse practical problems in the welding and joining field.

PEO3. Develop entrepreneur skills and collaborative aspects of their professional activity in an organized and productive fashion.

The Programe Outcomes of the welding technology programme are,

PO1. Apply knowledge of mathematics, science and engineering for the solution of engineering problems

PO2. Investigate, design and analyze system component or process to meet the desire needs in metallurgical engineering

PO3. Design and conduct experiments to find solutions in the field of metallurgical engineering

PO4. Conduct investigation of complex engineering problems in the field of metallurgical engineering to provide valid conclusions

PO5. Use modern engineering tools necessary for engineering activities with an understanding of the limitations

PO6. Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering practice.

PO7. Understand the impact of engineering solutions in societal and environmental context and explain the need for sustainable development

PO8. Understand and respect professional and ethical responsibility

PO9. Function on multi-disciplinary team as a leader or a team member

PO10. Communicate effectively both orally and in writing.

PO11. Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work

PO12. Recognize the need for, and have the preparation and ability to engage in life-long learning

At the end of this programme, welding Technology post graduates will be able to:

PSO1: Select and design welding processes and inspection techniques based on application, fabrication and service conditions.

PSO2: Specify materials based on application, fabrication and service conditions.

PSO3: Identify research gaps in multidisciplinary environments, which will provide a link to the development of innovative solutions for real- world challenges.

M.E. WELDING TECHNOLOGY – Full Time

Course code	Name of the Course	Hours/Week					Credit	Maximum Marks		
		Category	Contact periods	Lecture	Tutorial/ Demo*	Practical		CA	FE	Total
SEMESTER I										
22WT**C**11	Advanced Mathematics and Statistics	Core	3	3	-	-	3	40	60	100
22WT**C**12	Welding Processes – I	Core	3	3	-	-	3	40	60	100
22WT**E**__	Elective - I	PEC-1	3	3	-	-	3	40	60	100
22WT**E**__	Elective - II	PEC -2	3	3	-	-	3	40	60	100
22WT**C**13	Metallography Lab	Core	4	-	-	4	2	60	40	100
22WT**C**14	Joining Lab	Core	4	-	-	4	2	60	40	100
22**MLC01**	Research Methodology and IPR	MC	3	3	-	-	3	40	60	100
22AC____	Audit course – 1	Audit	2	2	-	-	0			
TOTAL			25	17	-	8	19	-	-	**700**
SEMESTER II										
22WT**C**21	Welding Processes – II	Core	3	3	-	-	3	40	60	100
22WT**C**22	Welding Metallurgy	Core	3	3	-	-	3	40	60	100
22WT**E**__	Elective – III	PEC-3	3	3	-	-	3	40	60	100
22WT**E**__	Elective - IV	PEC-4	3	3	-	-	3	40	60	100
22WT**C**23	Quality Control in Weldments Lab	Core	4	-	-	4	2	60	40	100
22WT**C**24	Characterization Lab	Core	4	-	-	4	2	60	40	100
22WT**C**25	Mini Project	EEC	4	-	-	4	2	60	40	100
22AC____	Audit course – 2	Audit	2	2	-	-	0			
TOTAL			26	14	-	12	18	-	-	**700**
SEMESTER III										
22WT**E**__	Elective - V	PEC-5	3	3	-	-	3	40	60	100
22WT**E**__	Elective - VI	PEC-6	3	3	-	-	3	40	60	100
22WT**C**31	Project Phase – I	EEC	20	-	-	20	10	120	80	200
TOTAL			26	6	-	20	16			**400**
SEMESTER IV										
22WT**C**41	Project Phase – II	EEC	34	-	-	34	17	240	160	400
TOTAL			34	-	-	34	17			**400**

Total Credits for the programme = 19 + 18 + 16 + 167= 70

PROFESSIONAL ELECTIVE COURSES (PEC)

Course Code	Name of Course
22WT**E**01	Physical Metallurgy and Heat Treatment
22WT**E**02	Welding Economics, Management and Safety
22WT**E**03	Composite Materials
22WT**E**04	Materials Characterization
22WT**E**05	Failure Analysis in Weldments
22WT**E**06	Testing and Inspection of Materials
22WT**E**07	Non - metallic Materials
22WT**E**08	Finite Element Analysis
22WT**E**09	Electrical Aspects of Welding
22WT**E**10	Total Quality System and Engineering
22WT**E**11	Automation and Robots in Welding
22WT**E**12	Welding Application Technology
22WT**E**13	Brazing, Soldering, Surfacing and Cutting
22WT**E**14	Corrosion and Surface Engineering
22WT**E**15	Design of Weldments
22WT**E**16	Industrial Safety
22WT**E**17	Welding Codes and Standards
22WT**E**18	Foundry Processes and Metallurgy
22WT**E**19	Forming Processes

AUDIT COURSES

Course Code	Name of Course
22**AC**01	English for Research Paper Writing
22**AC**02	Disaster Management
22**AC**03	Sanskrit for Technical Knowledge
22**AC**04	Value Education
22**AC**05	Constitution of India
22**AC**06	Pedagogy Studies
22**AC**07	Stress Management by Yoga
22**AC**08	Personality Development through Life Enlightenment Skills

22WTC11	ADVANCED MATHEMATICS AND STATISTICS	Semester			I
PREREQUISITES	Category	PC	Credit		3
Engineering Maths	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To familiarize with the numerical solution of linear and non-linear equations and fitting curves by the method of least squares.
2	To obtain the solutions of diffusion and wave equation by using techniques of Laplace and Fourier transforms.
3	To understand the significance of central limit theorem and testing of hypothesis.
4	To analyze the variance of factors by one way and two way classification and some standard design of experiments.
5	To familiarize with the numerical solution of linear and non -linear equations and fitting curves by the method of least squares.

Unit I	CURVE FITTING AND SOLUTION OF EQUATIONS	9	0	0	9

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 Seidal methods**.**

Unit II	LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS	9	0	0	9

Laplace transform: Definitions – Properties- Inverse Laplace transform- Solution of diffusion equation and wave equation by Laplace transform technique.

Unit III	FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS	9	0	0	9

Fourier transform: Definitions – Properties- Transform of elementary functions- Solution of Diffusion equation, wave equation and Laplace equation by Fourier transform technique.

Unit IV	STANDARD DISTRIBUTIONS AND TESTING OF HYPOTHESIS	9	0	0	9

Random variables- Standard discrete and continuous distributions (Binomial, Poisson, Normal, uniform and Exponential) – Central limit theorem and its significance- Testing a statistical hypothesis, Sampling distributions (t-test, F-test and Chi-square test).

Unit V	ANALYSIS OF VARIANCE AND DESIGN OF EXPERIMENTS	9	0	0	9

Analysis of variance -One way and Two way classifications- Principles of Design of Experiments- Some standard designs (Completely Randomized Design, Randomized Block design and Latin square design).

Total (45 L) = 45 Hours

Text Books:

1	K.Sankara Rao, "Introduction to Partial Differential Equations", Prentice Hall of India Pvt. Ltd., New Delhi, 2003.
2	Veerarajan. T, "Probability, Statistics and Random process", Tata McGraw- Hill publications, second edition, New Delhi, 2002.
	Kandasamy. P, Thilagavathy. K, Gunavathi. K, "Numerical Methods" S. Chand & Co., New Delhi, 2005.

Reference Books:

1	Grewal, B.S., "Higher Engineering Mathematics", 43rd edition, Khanna Publishers, New Delhi, 2014.
2	Andrews. L.C and Shivamoggi. B, "Integral Transforms for Engineers", Prientice Hall of India Pvt. Ltd., New Delhi, 2003.
3	Peter O'Neil, "Advanced Engineering Mathematics", 7th edition, Cengage Learning, 2012.

4	Gupta, S.C. and Kapur, V.K.,"Fundamentals of Mathematical Statistics", S. Chand and Sons, New Delhi, 11th Edition 2014
5	Devore, Jay L., "Probability and Statistics for Engineering and the Sciences",5th Edition, Brooks- Cole, 1999.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Obtain the numerical solution of linear and non-linear equations and fitting curves by method of least squares.	L2: Understanding
CO2	:	Obtain the solutions of diffusion and wave equation involved in engineering problems by using Laplace and Fourier transform techniques.	L2: Understanding
CO3	:	Gain the knowledge on statistical sampling and its applications, analysis of variance by one and two way classification	L4: Analysing
CO4	:	Improve Personality skills, Major determination in profession in group behaviour.	L3: Applying
CO5	:	Discuss the modern concepts for better industrial management.	L3: Applying

COURSE ARTICULATION MATRIX

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	2	2	2								1		
CO2	2	2	2	1	2								1		
CO3	2	2	2	2	2								1		
Avg.	2.0	2.0	2.0	1.7	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22WTC12	WELDING PROCESSES –I	Semester	I
PREREQUISITES	Category	PC	Credit 3
Manufacturing Technology	Hours/Week	L	T P TH
		3	0 0 3

Course Learning 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 AND GAS WELDING	9	0	0	9

Importance of welding, comparison of welding with other fabrication processes. Classification of welding processes, Heat sources for fusion welding, shielding methods, Nature and behavior of fluxes for welding, Shielding gases, Arc physics. Relationship between heat input and energy density, Oxy Fuel Gas Welding: Gases – set up of equipment – Flame characteristics, different kinds of flame and their applications, Variants of oxy fuel gas welding.

Unit II	SHIELDED METAL ARC WELDING	9	0	0	9

SMAW Process: Principle of the process, Electrodes, functions of flux coating, types of electrodes, Arc welding power sources and their applications, AWS Classifications of electrodes, electrode designations, defects, causes and remedies. Advantages, limitations and applications of SMAW process. Variants of SMAW process.

Unit III	GAS TUNGSTEN ARC WELDING AND PLASMA ARC WELDING	9	0	0	9

Gas Tungsten Arc Welding – Equipment, Electrodes, polarity, shielding gases, use of D.C. suppressors, arc starting and stopping, choice of filler metal composition, use of pulsed arc and GTA spot welding, other recent developments, advantages, limitations and applications, defects, causes and remedies. 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 and their applications.

Unit IV	GAS METAL ARC WELDING AND FLUX CORED ARC WELDING	9	0	0	9

Gas Metal Arc Welding- Principle of operation, Metal transfer mechanisms, Equipment, shielding gases, electrodes, Pulsed GMAW, Synergic GMAW, Cold Metal Transfer. Advantages, disadvantages and applications of GMAW. Flux cored arc welding–Process features, Equipment, Electrode manufacture and Electrode classification. Advantages, disadvantages and applications of Flux Cored Arc welding

Unit V	SUBMERGED ARC WELDING AND STUD ARC WELDING	9	0	0	9

Submerged arc welding – Principle of operation, Equipment, Flux classification, Basicity index, Electrodes, Variations of Process, Defects, Advantages, Disadvantages and Applications. Stud arc welding - Equipment, operation, Stud arc welding gun, Ferrules. Defects, Advantages, Disadvantages and applications in Stud Arc welding

Total (45 L) = 45 Hours

Reference Books:

1	Howard B. Cary, "Modern Welding Technology", Prentice Hall, 6th Ed.,2017
2	Parmar R.S. "Welding Processes and Technology" Khanna Publishers, 2nd Ed., 2005.
3	Nadkarni. S.V. "Modern Arc Welding Technology" Oxford IBH Publishing Co.2005.
4	AWS Welding Handbook.9th edition Volume1, "Welding Science and Technology",2013.
5	AWS Welding Handbook. 9th edition. Volume 2, "Welding Processes", 2013.

6	ASM Handbook, "Welding, Brazing and Soldering" Vol. 6, ASM2017.
7	ASM Handbook, "Welding Fundamentals and Processes" Vol. 6A, ASM2017
8	Lancaster J.F. "The Physics of Welding", Pergamon Press, 2nd Ed., 1986.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Identify and list the broad classification of various welding processes.	L2: Understanding
CO2	:	Explain the principle of operation, advantages, limitations and applications of SMAW process.	L3: Applying
CO3	:	Discuss the principle of operation, advantages, limitations and applications of GTAW and PAW processes.	L3: Applying
CO4	:	Explain the principle of operation, advantages, limitations and applications of GMAW and FCAW processes.	L3: Applying
CO5	:	Describe the principle of operation, advantages, limitations and applications of SAW, SW and CAW processes	L3: Applying

COURSE ARTICULATION MATRIX

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1											1		
CO2	2	1	1	2		1		1					2		1
CO3	2	1		1	1								2	1	1
CO4	1	2		1			1						1		
CO5	2	1											1		
Avg.	1.6	1.2	1.0	1.3	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	1.4	1.0	1.0

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22WTC13	METALLOGRAPHY LAB	Semester	I
PREREQUISITES	Category	PC	Credit 2
Engineering materials and Metallurgy	Hours/Week	L T P TH	0 0 4 4

Course Learning Objectives

1	To learn about sample preparation and metallurgical microstructure of metal in various product form and their conditions and same to be apply in various applications.

List of experiments

1	Study of metallurgical microscope and specimen preparation
2	Macro examination of samples
3	Microstructure of carbon steels and alloy steels
4	Microstructure of cast irons
5	Microstructure of non-ferrous alloys
6	Microstructure of heat treated/processed samples
7	Grain size measurement
8	Study of weld bead characteristics
9	Microstructure of weldments (Similar and Dissimilar)
10	Micro hardness survey of weldments

Total = 60 Hours

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Prepare the specimens for suitable metallographic examination with best practices.	L4:Analysing
CO2	:	Perform macro examinations with aid of profile projector	L4:Analysing
CO3	:	Operate metallurgical microscopes and examine the specimens.	L2: Understanding
CO4	:	Identify, analyze and interpret various microstructure of materials	L4:Analysing

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	1	1					1	1	2	
CO2	1		2	2	2	1							2	2	1
CO3	1	1	1	1	2	1						1	1	1	1
CO4	1		1	2	2	1							2	2	
Avg.	1.0	1.0	1.3	1.5	1.8	1.0	1.0	0.0	0.0	0.0	0.0	1.0	1.5	1.8	1.0

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22WTC14	JOINING LAB	Semester	I
PREREQUISITES	Category	PC	Credit 2
Manufacturing Technology	Hours/Week	L T P TH	0 0 4 4

Course Learning Objectives	
1	To gain knowledge in simple operation of welding machines, practical aspects of welding processes and able to apply in various joining applications.

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
10	Weldability test for Cold cracking
	Total = 60 Hours

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Generate arc, and identify the process parameters and their effects during welding.	L2: Understanding
CO2	:	Prepare and select the process parameters for bend practices by producing butt and fillet joints.	L4:Analysing
CO3	:	Perform various solid state welding processes and understanding its process parameters.	L2: Understanding
CO4	:	Evaluate cold or hot cracking susceptibility of different alloys.	L2: Understanding

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1		1								1		
CO2	1		1		1	1							2	1	1
CO3	1	1	2	1									1		
CO4	1		1		1	1							1		
Avg.	1.0	1.0	1.3	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	1.0	1.0

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22MLC01	RESEARCH METHODOLOGY & IPR		Semester			I
PREREQUISITES		Category	MC	Credit		3
NIL		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To develop the subject of their research
2	Development required in writing research proposals, reports and dissertation

Unit I	**INTRODUCTION TO RESEARCH**	9	0	0	9

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting are search problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

Unit II	**EFFECTIVE LITERATURE STUDIES, APPROACHES, ANALYSIS**	**9**	**0**	**0**	**9**

Developing the theoretical framework of research- Developing operational statements problems- Criteria for evaluating research approach- Hypothesis: parametric and non- parametric testing- Establishing the reliability and validity of findings with literature review and experiment documentation, Plagiarism, Research ethics.

Unit III	**EFFECTIVE TECHNICAL WRITING, HOW TO WRITE REPORT, PAPER**	**9**	**0**	**0**	**9**

Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

Unit IV	**NATURE OF INTELLECTUAL PROPERTY**	**9**	**0**	**0**	**9**

Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit V	**PATENT RIGHTS AND IPR**	**9**	**0**	**0**	**9**

Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Total (45 L) = 45 Hours

Reference Books:

1	Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering student’s”
2	Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”
3	Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners”
4	Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd, 2007.
5	Mayall , “Industrial Design”, McGraw Hill,1992.
6	Niebel , “Product Design”, McGraw Hill,1974.
7	Asimov, “Introduction to Design”, Prentice Hall, 1962.
8	Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”, 2016.
9	T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Understand research problem formulation.	L2: Understanding
CO2	:	Analyze research related Information.	L4:Analysing
CO3	:	Follow research ethics.	L3:Applying
CO4	:	Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.	L2: Understanding
CO5	:	Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.	L2: Understanding

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1						1	1	1	1	1	1	1			1
CO2						1	1	1	1	1	1	1			1
CO3						1	1	1	1	1	1	1			1
CO4						1	1	1	1	1	1	1			1
CO5						1	1	1	1	1	1	1			1
Avg.	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22WTC21	WELDING PROCESSES–II		Semester			II
PREREQUISITES		Category	PC	Credit		3
Manufacturing technology		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning 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 AND LASER BEAM WELDING	9	0	0	9

Heat generation and regulation, equipment details in typical set-up, electron beam welding in different degrees of vacuum, advantages, disadvantages 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	0	0	9

Electro slag welding - Heat generation, principles of operations, wire and consumable guide techniques, selection of current, voltage and other process variables, nature of fluxes and their choice, applications, variants of electro slag welding, Electro gas welding.
Resistance welding - Principles of contact resistance, surface preparation, calculation of current, time and voltage for spot welding – Temperature distribution, spot welding cycle, inter-relationship between process variables, choice of electrode material, seam welding, projection welding. Flash welding, Upset welding, Percussion welding, High frequency welding.

Unit III	SOLID STATE WELDING PROCESSES	9	0	0	9

Advantages of solid state welding processes over conventional welding processes. High temperature solid state welding, Low temperature solid state welding, Fundamental principles, Overview of various solid state welding processes and principles of operation, applications.
Cold pressure welding, Induction pressure welding, Explosive welding, Diffusion welding, Ultrasonic welding, Forge welding, Roll welding–Principles of operation, equipment, process characteristics advantages, limitations and applications.

Unit IV	FRICTION AND FRICTION STIR WELDING	9	0	0	9

Friction Welding- Theoretical considerations, Process characteristics, Friction Welding machines and equipments, welding variables, weld properties, joint design, applications.
Friction Stir Welding - Principles of operation, Important welding parameters - tool rotation and traverse speeds, tool tilt and plunge depth, tool design. Generation and flow of heat, advantages, limitations and applications. Flaws and defects in FSW - Friction surfacing and friction stir processing.

Unit V	OTHER JOINING PROCESSES, CUTTING AND SURFACING	9	0	0	9

Adhesive bonding – Concept, Procedure, Testing of Adhesive bonded joints, types of adhesive bonded joints, Sandwich Construction, selection and types of adhesives. Welding of plastics, Underwater Welding. Thermit Welding, Brazing and Soldering -Fundamentals, Types, brazing and soldering alloys and their classification. Thermal cutting – Oxy-fuel cutting, arc cutting, plasma arc cutting, laser cutting. Surfacing.

Total (45 L) = 45 Hours

Reference Books:

1	AWS Welding Handbook. 9thedition. Volume 2, Welding Processes, 2013.
2	Schwartz M.M., “Metals Joining Manual”, McGraw Hill Books.1979.
3	Metals Handbook (Welding, Brazing and Soldering), Vol. 6, 10th Edition. ASM1995.

4	Howard B. Cary, "Modern Welding Technology", Prentice Hall, 6th Ed., 2017.
5	Tylecote R.F., "The Solid Phase Welding of Metals", Edward Arnold Publishers Ltd. London.1968.
6	Christopher Davis, "Laser Welding - Practical Guide", Jaico Publishing House, 1994.
7	Parmar R.S. "Welding Processes and Technology", Khanna Publishers, 2nd Ed., 2005.
8	ASM Handbook, "Welding Fundamentals and Processes" Vol. 6A, ASM 2017

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Explain the principle of operation, advantages, limitations and applications of various solid state welding processes.	L3:Applying
CO2	:	Discuss the principle of operation, advantages, limitations and applications of FRW and FSW processes.	L3:Applying
CO3	:	Explain the principle of operation, advantages, limitations and applications of EBW and LBW processes.	L3:Applying
CO4	:	Explain the principle of operation, advantages, limitations and applications of ESW and Resistance welding processes.	L3:Applying
CO5	:	Describe the principle and features of various special joining techniques and thermal cutting methods	L2: Understanding

L3:Applying

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1												1		
CO2	2	1		1		1	1						1		
CO3	2		1										1		
CO4		1		1	1								1		
CO5	1	1												1	1
Avg.	1.5	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22WTC22	WELDING METALLURGY	Semester	II
PREREQUISITES	Category	PC	Credit 3
Manufacturing technology, Engineering materials and metallurgy	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To gain understanding of heat flow and temperature distribution on weld components based on weld geometry.
2	To understand the solidification structure and growth morphology on weld joins in relation to the welding parameters.
3	Study phase transformations in weld joints with aid of CCT, Schaffler and Delong diagrams and welding of alloy steels, carbon steels and stainless steels.
4	Study of weldability of various non-ferrous alloys.

Unit I	HEAT FLOW IN ARC WELDING	9	0	0	9

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 these considerations. 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	0	0	9

Concept of Weldability, Factors affecting Weldability, Welding Defects, Causes and remedies, Cracking phenomena in welding, Characterization of weldments, Weldability tests - cold cracking tests, hot cracking tests, Internal restraint tests, External restraint tests, Mechanical tests for weldments-Tension tests and Bend tests.

Unit III	WELDABILITY OF CARBON STEELS AND LOW ALLOY STEELS	9	0	0	9

Formation of different microstructural zones in welded plain carbon steels, C-Mn and low alloy steels. Phase transformation in weldmetal and heat affected zones. Hydrogen induced cracking, Carbon equivalent, preheating, Post heating and post weld heat treatment, Hot cracking – compositional features – Effect of S and P, Reheat cracking and Lamellar cracking.

Unit IV	WELDABILITY OF STAINLESS STEEL	9	0	0	9

Introduction to stainless steel classification, effect of alloying elements, Austenitising elements, Ferritising elements, Weldability of austenitic stainless steels – Hot cracking – constitution diagrams – Schaffler, Delong, WRC diagrams, Mode of solidification, Sensitization, Sigma embrittlement. Metallurgical difficulties in welding of ferritic, martensitic and duplex stainless steels, selection of filler metals.

Unit V	WELDABILITY OF OTHER ALLOYS AND DISSIMILAR WELDING	9	0	0	9

Welding of cast irons, High Cr steels, Maraging Steels – Process, procedure and filler metal selection, weldability problems encountered and solutions.

Weldability of Al alloys, Cu Alloys, Ti Alloys and Ni Alloys – Selection of welding process and procedure appropriate for each material.

Dissimilar welding: Metallurgical problems in dissimilar welding- calculation of dilution- methods of controlling dilution - techniques of dissimilar welding.

Total (45 L) = 45 Hours

Reference Books:

1	Parmar R.S., “Welding Engineering and Technology”, Khanna Publishers.1997.
2	Lancaster J.F., “Metallurgy of Welding”, George Allen & Unwin. Boston.1980.
3	Kou. S., “Welding Metallurgy”, John Wiley & Sons.1987.
4	Granjon. H., “Fundamentals of Welding Metallurgy”, Jaico Publishing House. New Delhi, 1994.

5	Norman Bailey, "Weldability of Ferritic Steels", Jaico Publishing House,1997
6	AWS Welding Hand book. 8th edition. Vol-1. Welding Technology, 1998.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Illustrate the heat flow in welding, structures formed and effect of various welding parameters.	L2: Understanding
CO2	:	List and explain the various types of weldability tests.	L4:Analysing
CO3	:	Discuss the weldability of carbon steel and low alloy steels and weldability issues.	L2: Understanding
CO4	:	Analyse the weldability of stainless steel.	L4:Analysing
CO5	:	Apply various welding process, procedure, and filler metal selection for the welding of cast iron, non-ferrous alloys and for dissimilar welding.	L3:Applying

COURSE ARTICULATION MATRIX

CO/PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1	1											1		
CO2	1	2	1	2		1							1		
CO3	2	1	1	1	1									2	1
CO4	2	2		1			1							2	
CO5	1	1											1		
Avg.	1.4	1.4	1.0	1.3	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	2.0	1.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22WTC23	QUALITY CONTROL IN WELDMENT LAB	Semester	II
PREREQUISITES	Category	PC	Credit 2
Manufacturing technology, Engineering materials and metallurgy	Hours/Week	L: 0	T: 0	P: 4	TH: 4

Course Learning Objectives

1	To learn about welding measuring gauges, principles of material testing and inspection documents (reports) for quality control in welding applications

List of experiments

1	Study of Welding Gauges and Measuring Equipments
2	Preparation of WPS and PQR
3	Preparation of Welder qualification test
4	Tensile test of weldments
5	Bend test of weldments
6	Impact test of weldments (notch location - weld metal, HAZ and parent material) - room temperature and low temperature
7	Fit-up inspection
8	Visual Inspection
9	Dye-Penetrant Testing and Magnetic Testing Examination
10	Radiographic Film Interpretation
11	Study of Inspection, Testing and Plan(ITP)
12	Review of MTCs (Material/Mill Test Certificate) and BTCs (Batch Test Certificate) - Raw materials and Welding Consumables

Total = 60 Hours

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Explain the practical aspects of welding gauges and their applications.	L2: Understanding
CO2	:	Hands on experience in material testing and their sample preparation.	L3:Applying
CO3	:	Exposure of Quality control documents - Read and understand the various reports	L3:Applying
CO4	:	Understand and report welding documents (WPS, PQR &WPQ).	L2: Understanding

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1			1							1		
CO2	1		2		1	1							1		1
CO3	1	1	1	1		1								1	
CO4	1		1			1							1		
Avg.	1.0	1.0	1.3	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22WTC24	CHARACTERIZATION LAB		Semester			II
PREREQUISITES		Category	PC	Credit		2
Engineering materials and metallurgy		Hours/Week	L	T	P	TH
			0	0	4	4

Course Learning Objectives	
1	To learn the principles of material characterization and to apply them for various engineering applications.
List of Experiments	
1	Identification of Planes by Stereographic projection.
2	Indexing of patterns in XRD graphs.
3	Estimation of precise lattice parameter of cubic crystals.
4	Determination of crystallite size and r.m.s. strain for mechanically alloyed powder.
5	Interpretation of Thermal analytical curves.
6	Analysis of SEM fractographs.
7	Analysis of TEM images of metals and alloys.
8	Determination of volume fraction of phases using image analysis.
9	Determination of nodularity and nodule count in cast iron using image analysis.
10	Corrosion rate determination by a) weight loss method, b) effect of inhibitor.
11	Evaluation of corrosion characteristic by Polarization technique.
	Total = 60 Hours

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Identify and mark the pole figures.	L2: Understanding
CO2	:	Illustrate the index of XRD and examine the applications of XRD pattern.	L4:Analysing
CO3	:	Interpret the DSC curves and analyze the SEM and TEM images of metal and alloys.	L4:Analysing
CO4	:	Analyze images for determining volume fraction of phases and the nodularity and nodule count in cast iron.	L4:Analysing
CO5	:	Evaluate the corrosion rate by weight loss method, the effect of inhibitor on rate of corrosion, and the corrosion characteristics by Polarization method.	L3:Applying

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1			1									1		
CO2	1		2	1									1		
CO3	2	1	2	1										1	1
CO4		1			1								1		
CO5	1				1										1
Avg.	1.3	1.0	2.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

PROFESSIONAL ELECTIVE COURSES (PEC)

22WTE01	PHYSICAL METALLURGY AND HEAT TREATMENT	Semester			
PREREQUISITES	Category	PE	Credit		3
Engineering materials and metallurgy	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To impart knowledge on the phase diagrams, properties and applications of ferrous and non-ferrous alloys so as to identify and select suitable materials for various engineering applications.
2	To know the fundamental concepts of various heat treatment processes.

Unit I	**PHASE DIAGRAMS**	**9**	**0**	**0**	**9**

Phases, solid solution types, compounds, Hume- Rothery rules; Gibb's phase rule; Binary isomorphous alloy systems – composition and amount of phases, development of microstructure – equilibrium and non-equilibrium cooling, Fe-C Equilibrium diagram - effects of alloying elements – Ferrite and Austenite Stabilizers, TTT and CCT diagrams.

Unit II	**FERROUS ALLOYS**	**9**	**0**	**0**	**9**

Plain carbon steels – low alloy and Q and T steels dual phase steels – ultra high strength steels - maraging steels – HSLA steels – High Cr steels - processing, properties & applications.
Stainless steels- effects of chromium and nickel – ferritic and Austenitic, martensitic, duplex and precipitation hardened stainless steels. Types of Cast Irons- Gray Cast iron, white iron, malleable iron, S.G. Iron and alloy cast irons –physical metallurgy, composition of cast irons, properties and applications.

Unit III	**NON –FERROUS ALLOYS**	**9**	**0**	**0**	**9**

Physical metallurgy, composition, properties and applications of Cu alloys, Al Alloys, Ti alloys, Ni alloys and Mg alloys.

Unit IV	**HEAT TREATMENT PROCESSES**	**9**	**0**	**0**	**9**

Annealing - types, Normalizing, Hardening - Retained austenite -measurement and methods of its elimination, Hardenability studies- Jominy end quench test, Grossman's experiments, Tempering Austempering and Martempering, Heat treatment of gray cast irons, white cast irons, malleabilising and S.G.irons. Heat treatment of aluminium alloys and copper alloys.

Unit V	**CASE HARDENING**	**9**	**0**	**0**	**9**

Introduction, Carburising: Principle, carbon potential, application of Fick's law, methods of carburising, heat treatment after carburising, structure, properties and common problems in carburising. Nitriding: introduction, steels used, effects of microstructure, white layer, nitriding methods, Carbo nitriding, Cyaniding, Induction and Flame hardening: principle, methods, operating variables. Measurement of case depth.

Total = 45 Hours

Reference Books:

1	Raghavan V. "Physical Metallurgy – Principles and Practice", Prentice Hall of India, 2nd Edition, 2011.
2	Williams D Callister, "Material Science and Engineering", Wiley India Pvt Ltd, Revised Indian Edition 2007.
3	Flinn. R.A. and Trojan. P.K. "Engineering Materials and their Applications", 4th Edition, Jaico, 1999.
4	Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 4th Indian Reprint 2002.
5	Metals Hand book. 10th edition. Volumes 1, 2 and 3, ASM.2018

6	Rajan and Sharma "Heat Treatment Principles and Techniques" –Prentice Hall of India (P) Ltd, New Delhi, 2009.
7	Vijendra Singh, "Heat Treatment of Metals", Standard Publishers Distributors, Delhi, First edition 1998.
8	Romesh.C. Sharma, "Principles of Heat Treatment of Steels", New Age International Pvt. Ltd. Publishers, New Delhi, 2008.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Explain the formation of solid solutions, construct the phase diagrams and understand the TTT and CCT diagrams.	L2: Understanding
CO2	:	Discuss the principal effects on properties of the major alloying elements used in steels and analyze the basic structure and properties of different types of cast irons.	L4:Analysing
CO3	:	Explain the properties and applications of some important non-ferrous metals such as Cu, Al, Ti, Ni, Mg and their alloys.	L2: Understanding
CO4	:	Discuss the various heat treatment processes for specific alloys.	L2: Understanding
CO5	:	Elaborate the various case hardening processes, advantages, limitations and it's applications.	L3:Applying

COURSE ARTICULATION MATRIX

CO/PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1			1									1		
CO2	1	1			1									1	
CO3		1		1										1	
CO4	1				1	1							1		
CO5	1			1			1						1		
Avh.	1.0	1.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	0.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22WTE02	WELDING ECONOMICS, MANAGEMENT AND SAFETY	Semester			
PREREQUISITES	Category	PE	Credit		3
Manufacturing technology, Engineering materials and metallurgy	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To design a system, a component, or a process to meet desired needs within realistic constraints such as Factors influencing welding cost, Estimation of welding time, costing for welding, plant layout setup, Safety practices in welding & its manufacturability and sustainability.

Unit I	**FACTORS INFLUENCING WELDING ECONOMICS**	**9**	**0**	**0**	**9**

Welding design-selection of electrodes, size, type and metal recovery–electrode efficiency, sub, thrown away electrodes – over welding and joint fit – up welding position - operation factor – jigs, fixtures, positioners, Operator efficiency.

Unit II	**ESTIMATION OF WELDING TIME**	**9**	**0**	**0**	**9**

Need for time standard – definition of standard time- various methods of computing standard time – analytical calculation – computerization of time standards.

Unit III	**ESTIMATION AND COSTING FOR WELDING**	**9**	**0**	**0**	**9**

Definition of terms – composition of welding costs, cost of consumables – labour cost–cost over heads - formulae for total cost – cost curves for different processes like GMAW, SAW, ESW, Mechanization in welding – job shop operation.

Unit IV	**PROCESS AND PLANT LAYOUT**	**9**	**0**	**0**	**9**

Process vs product lay out – construction – service consideration – employees- services, welding shop equipment, oxy acetylene stations- resistance welding; power tools - blast stations – inert gas welding stations – arc welding stations – crane forges - jigs and fixtures cleaning supplies- welding equipment repair shop - proper arrangement of the above in the welding shop for maximum convenience and ease of production.

Unit V	**SAFE PRACTICES IN WELDING**	**9**	**0**	**0**	**9**

Selection and installation of equipments, safe handling equipment- fire prevention- eye and face protection - respiratory protection - ventilation -protective extra clothing - electric shock- safety analysis.

Planning for welding operations, production control planning for welding processes- pre- production planning- routing - scheduling. activating, monitoring, materials management in welding- Inventory control- Basic aspects of financial management and man-power planning

Total = 45 Hours

Reference Books:

1	ASM Metals Handbook, Vol.6, “Welding, Brazing and Soldering”, ASM, New York, 1998.
2	AWS Welding Handbook, vol.5, “Engineering Costs, Quality and Safety”, 9th edition, AWS, 2015.
3	John Norrish, “Arc Welding Processes - Technologies and process control”, Woodhead Publishing and Maney Publishing on behalf of The Institute of Materials, Minerals & Mining, 2006.
4	Standard Data for Arc Welding – The Welding Institute, U.K., 1994.
5	Bathy. J., “Industrial Administration and Management”, 1984.
6	The Procedure Handbook of Arc Welding, 12tn Edition, Lincoln Electric, USA, 2003.
7	ASM Metals Handbook, Vol.6, “Welding, Brazing and Soldering”, ASM, New York, 1998.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Illustrate various factors influencing the welding cost.	L2: Understanding
CO2	:	Estimate the standard welding time using various methods for the welding processes.	L4:Analysing
CO3	:	Calculate the welding cost for the different welding processes.	L4:Analysing
CO4	:	Explain various requirements on setting up a welding plant layout.	L2: Understanding
CO5	:	Discuss the safety measures during welding processes and planning operations.	L2: Understanding

COURSE ARTICULATION MATRIX

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1			1								1		
CO2	1	2	1		1		1								1
CO3	2	1		2		1					1	1	2		
CO4		1		1	2								2		
CO5	1		1		1						1			1	
Avg.	1.3	1.3	1.0	1.5	1.3	1.0	1.0	0.0	0.0	0.0	1.0	1.0	1.7	1.0	1.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22WTE03	COMPOSITE MATERIALS		Semester			
PREREQUISITES		Category	PE	Credit		3
Engineering materials and metallurgy		Hours/Week	L	T	P	TH
			3	0	0	3
Unit I	INTRODUCTION TO COMPOSITES		9	0	0	9
Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.						
Unit II	REINFORCEMENTS		9	0	0	9
Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.						
Unit III	MANUFACTURING OF METAL MATRIX COMPOSITES		9	0	0	9
Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.						
Unit IV	MANUFACTURING OF POLYMER MATRIX COMPOSITES		9	0	0	9
Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.						
Unit V	STRENGTH OF COMPOSITES		9	0	0	9
Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hydrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.						
						Total = 45 Hours

Reference Books:

1. Material Science and Technology – Vol 13 – Composites by R.W. Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. W D Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition,2007.

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom's Taxonomy Mapped
CO1	:	Classify the composites and explain their properties.	L2: Understanding
CO2	:	Distinguish various reinforcements used in composites.	L4:Analysing
CO3	:	Explain the processing of metal matrix composites and their applications	L2: Understanding
CO4	:	Explain the processing of polymer matrix composites and their applications	L2: Understanding
CO5	:	Identify the mechanism of composites and determine the laminates stress within laminates.	L3:Applying

COURSE ARTICULATION MATRIX															
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1		1	1								1		
CO2		1	1		1									1	1
CO3	1	1		1		1							2		
CO4	2				1								2		
CO5	1													1	
Avg.	1.3	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	1.0	1.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22WTE04	MATERIALS CHARACTERIZATION		Semester			
PREREQUISITES		Category	PE	Credit		3
Engineering materials and metallurgy		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To acquire knowledge on various characterizations, chemical and thermal analysis techniques to analyses the metallurgical components.

Unit I	**METALLOGRAPHIC TECHNIQUES**	**9**	**0**	**0**	**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**	**0**	**0**	**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	**APPILICATIONS OF X-RAY DIFFARACTION**	**9**	**0**	**0**	**9**

Diffractometer – general feature and optics – proportional scintillating and Geiger counters. X-ray diffraction application in determination of crystal structure, lattice parameter and residual stress – quantitative phase estimation.

Unit IV	**ELECTRON MICROSCOPY**	**9**	**0**	**0**	**9**

Construction and operation of Transmission Electron Microscopy – Diffraction effects and image formation, specimen preparation techniques, elemental analysis by wavelength dispersive and energy dispersive systems. Construction and operation of Scanning Electron Microscopy, Scanning Transmission Electron Microscopy, Scanning Probe Microscope and Atomic force microscopy. Evaluation of samples by above microscope.

Unit V	**ADVANCED CHEMICAL AND THERMAL ANALYSIS METHODS**	**9**	**0**	**0**	**9**

X-ray fluoroscopy, Spectroscopy- principles, Atomic Absorption Spectroscopy, Optical Emission Spectroscopy, Auger spectroscopy. Differential Thermal Analysis, Differential Scanning Calorimetry and Thermo Gravimetry Analysis, Stress analysis.

Total = 45 Hours

Reference Books:

1	P.C. Angelo, "Materials Characterisation", Elsevier (India) Pvt. Ltd, Haryana, 2013.
2	Philips V.A. "Modern Metallographic Techniques and their Applications", Wiley Interscience, 1971.
3	Cullity B.D., "Elements of X- ray Diffraction", 2iiu Edition, Addison Wiley, 1978.
4	ASM Metals Handbook, Vol.10, Material Characterization, ASM, New York, 1998.
5	Thomas. G, "Transmission Electron Microscopy of Metals", John Wiley.1961.
6	Smallman R.E., "Modern Physical Metallurgy", 4uu Edition, Butterworths.1985.
7	Loretto. M.H., "Electron Beam Analysis of Materials", Chapman and Hall, 1984.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Describe the principle of various optical microscopic techniques.	L2: Understanding
CO2	:	Demonstrate the bragg's law of diffraction and the principle of XRD.	L4:Analysing
CO3	:	Determine crystal structure, lattice parameter, phase identification, solvus line estimation and residual stress analysis using XRD.	L2: Understanding
CO4	:	Describe the principle of various electron optical techniques.	L1: Remembering
CO5	:	Explain the analysis of composition, thermal and stress variations using spectroscopy, and calorimeters etc.,	L3:Applying

COURSE ARTICULATION MATRIX

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2			1	1							1	2		
CO2	1		1										1		
CO3		2												2	
CO4	1			2	1							1	2		1
CO5	1		1	1	2							1	1		2
Avg.	1.3	2.0	1.0	1.3	1.3	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.5	2.0	1.5
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22WTE05	FAILURE ANALYSIS IN WELDMENTS		Semester			
PREREQUISITES		Category	PE	Credit		3
Engineering materials and metallurgy		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To understand the concepts on failure and fracture analysis of weldments and to design new materials that can withstand catastrophic failures of weldments at different environment.

Unit I	**INTRODUCTION TO FAILURE ANALYSIS**	**9**	**0**	**0**	**9**

Stages of failure analysis, classification and identification of various types of fracture. Overview of fracture mechanics, characteristics of ductile and brittle fracture.

Unit II	**WELDMENT SURFACE FAILURES**	**9**	**0**	**0**	**9**

Types of wear, analyzing wear failure. Corrosion failures- factors influencing corrosion failures, overview of various types of corrosion stress corrosion cracking, sources, characteristics of stress corrosion cracking. Procedure for analyzing stress corrosion cracking, various types of hydrogen damage failures.

Unit III	**WELDMENT CREEP AND FATIGUE FAILURES**	**9**	**0**	**0**	**9**

General concepts, fracture characteristics revealed by microscopy, factors affecting fatigue life, Creep, stress rupture, elevated temperature fatigue, metallurgical instabilities, environmental induced failure. Some case studies on weldment failures.

Unit IV	**FAILURE OF WELDED PRODUCTS**	**9**	**0**	**0**	**9**

Causes of failure in forge weldments, failure of welded iron and steel castings, improper heat treatment of weldments, stress concentration by weldments, in-service weldment failures. Procedure for weld failure analysis and data extraction.

Unit V	**RELIABILITY**	**9**	**0**	**0**	**9**

Reliability concept and hazard function, life prediction, condition monitoring, application of Poisson, exponential and Weibull distribution for reliability, bathtub curve, parallel and series system, mean time between failures and life testing.

Total = 45 Hours

Reference Books:

1	Colangelo. V.J. and Heiser. F.A., “Analysis of Metallurgical Failures”, John Wiley and Sons Inc. New York, USA, 1987.
2	Das, A.K., “Metallurgy of Failure Analysis”, Tata McGraw Hill, New Delhi, 1992.
3	Donald J. Wulpi, “Understanding how components fail”, ASM International, 3rd Edition, 2013.
4	ASM Metals Handbook “Failure Analysis and Prevention”, ASM Metals Park. Ohio, Vol.10, 10th Edition, 1995.
5	Colangelo. V.J. and Heiser. F.A., “Analysis of Metallurgical Failures”, John Wiley and Sons Inc. New York, USA, 1987.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Explain the types of fracture and their analysis.	L2: Understanding
CO2	:	List the various factors causing failures of weldments.	L2: Understanding
CO3	:	Analyze the causes for Fatigue and Creep failures.	L4:Analysing
CO4	:	Discuss failure of various welded product forms.	L2: Understanding
CO5	:	Explain various concepts in reliability.	L2: Understanding

COURSE ARTICULATION MATRIX

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO3**
CO1	1	1		1		1								1	
CO2	2	1	1										1		
CO3		1		1	1		1						1		
CO4	1	2		1										1	
CO5		1											1		
Avg.	1.3	1.2	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	0.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22WTE06	TESTING AND INSPECTION OF MATERIALS	Semester	

PREREQUISITES	Category	PE	Credit		3
Engineering materials and metallurgy	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To impart knowledge in destructive and non-destructive testing with case studies.
2	To provide an understanding of the basic principles of various testing and inspection.

Unit I	DESTRUCTIVE TESTS	9	0	0	9

Tensile test- Engineering stress- strain curve, True Stress- strain curve, Testing machines and procedures. Impact test- Izod and Charpy impact test, Ductile to Brittle Transition Temperature (DBTT), determination of DBTT, Nick Break Test, Drop Weight tests and other large scale tests. Hardness test- Brinell, Vicker's and Rockwell hardness tests. Bend tests. Nano indentation.

Unit II	SURFACE NDT TECHNIQUES	9	0	0	9

NDT vs. Conventional testing. Visual inspection, Liquid penetrant Inspection: Principle, applications, advantages and limitations. Dyes, developers, and cleaners, fluorescent penetrant test, application of liquid penetrant testing to weldments. Magnetic particle Inspection: Principle, application, magnetization methods, magnetic particles, dry and wet technique, demagnetization. Principle, application and Instrumentation of Eddy current testing. Thermal inspection methods.

Unit III	RADIOGRAPHY AND OTHER NDT TECHNIQUES	9	0	0	9

X-Ray Radiography: Types of radiation, production of X-rays, properties of X-rays relevant to NDE, types and use of filters and screens, geometric factors, inverse square Law, film types and processing, characteristics of films – grain fineness, density, speed, contrast, characteristic curves, penetrameters, Exposure charts, radio graphic equivalence.

Gamma Ray Radiography: Gamma ray sources, characteristics of Gamma ray sources, Gamma ray exposure chart. Measurement of radioactivity, radiation hazards, units of radiation dose measurement, permissible radiation dose, radiation detection and measurement instruments, protection against radiation. Fluoroscopy technique, standard radiographs, Interpretation of radiographs, application of radiographic testing to weldments. Digital radiography. Acoustic Emission Techniques, Holography, Leak testing – hydrostatic testing, bubble leak test, pneumatic testing, service leak test.

Unit IV	ULTRASONIC INSPECTION	9	0	0	9

Types of ultrasonic waves, principle of wave propagation, characteristics of ultrasonic waves, attenuation, production of ultrasonic waves, couplants. Inspection methods – Pulse echo, transmission and resonance, thickness measurement. Types of scanning, test blocks, IIW reference block. Calibration of ultrasonic equipment, application of ultrasonic testing to weldments, Time of flight diffraction (TOFD), Phased array Ultrasonic Testing.

Unit V	OVERVIEW OF CODES AND STANDARDS RELATED TO NDT &WELDING	9	0	0	9

Qualification of inspectors as per ASNT and their authority and responsibility. Elementary introduction to AWS documents on following subject areas like definition and symbols, filler metals Qualification and Testing, API codes on pipelines and refinery equipments and storage tanks for refinery service, ASME–Boiler and Pressure vessel code Section II,V,VIII & IX, ASME code for pressure pipings - the purpose of respective code only. Welding Procedure Specifications, Procedure Qualification Records, Welder Performance Qualification.

Total = 45 Hours

Reference Books:

1	Dieter G. E., "Mechanical Metallurgy", SI metric Edition, McGraw Hill Books, 1988.

2	Baldevraj, Jayakumar.T., Thavasimuthu. M., "Practical Non-destructive Testing", Narosa Publishers.1997.
3	AWSWeldingHandbook,vol.5,"EngineeringCosts,QualityandSafety",7th Ed, AWS, 1997
4	Hull, "Non Destructive Testing", ELBS Edition, 1991.
5	McGonnagle. W.J. "Non-Destructive Testing", Gordon and Breach, 2nd Ed., 1971.
6	ASM Metals Hand Book. Vol. 9. Non-destructive Testing and Inspection, 1988.
7	Codes and Standards- ASNT, AWS D1.1, API1104, ASME- Boiler & Pressure Vessel Code – Section II, V, VIII,IX.
8	ASNT Nondestructive Testing Handbooks, Third Edition, American Society for Nondestructive Testing.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Outline the destructive testing such as tensile test, impact test and hardness test.	L2: Understanding
CO2	:	Select the suitable NDT techniques for surface analysis.	L3:Applying
CO3	:	Demonstrate the applications of X ray radiography and gamma ray radiography.	L3:Applying
CO4	:	Discuss the principle, inspection methods and applications of ultrasonic inspection.	L3:Applying
CO5	:	Identify suitable codes, standards and specifications for NDT.	L3:Applying

COURSE ARTICULATION MATRIX

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1		1									1		
CO2	2	1			1								1		
CO3		2	1	1		1							2		1
CO4	1	1		1									1		
CO5	1														1
Avg.	1.3	1.3	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	1.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22WTE07	NON-METALLIC MATERIALS		Semester			
PREREQUISITES		Category	PE	Credit		3
Engineering materials and metallurgy		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To know various types of polymers, ceramics and composites and its related concepts, understand processing and behaviour of it.

Unit I	INTRODUCTION TO POLYMERS	9	0	0	9

Classification- thermoset, thermoplastics and elastomers. Structure of polymers-crystalline and amorphous polymers-concept of Glass Transition Temperature (Tg). Polymerization- types and mechanisms with examples Degree of polymerization -molecular weight of polymers- 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, nitrile rubbers.

Unit II	PROCESSING AND BEHAVIOUR OF POLYMERS	9	0	0	9

Brief description of equipments and process details of Extrusion, injection moulding, Reaction and 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	0	0	9

Review of bonding types in ceramics – calculation of percentage ionic character. Ceramic crystal structures: Sodium chloride, cesium chloride, alumina, spinel and fluorite structures - examples. Co-ordination number and ionic radius ratio - Pauling's Rules. Simple problems involving Packing Fraction, critical radius ratio and density. Properties and applications of SiC, Cubic Boron Nitride, PSZ, Barium Titanate, Iron ferrites, etc

Unit IV	PROCESSING OF CERAMICS AND GLASSES	9	0	0	9

Brief description of slip and slurry casting, applications. Powder processing equipment and process details of hot pressing. Hot Isostatic Pressing and Cold Isostatic pressing, Liquid Phase sintering. Types of glasses, structure, properties and applications. Blowing, pressing, drawing, rolling and casting, Pilkington process for float glass.

Unit V	COMPOSITES	9	0	0	9

Polymer Matrix Composites: Polymer matrix resins, Reinforcement fibers – various types of fibers. PMC processes - Hand lay-up processes, Spray up processes, Compression moulding, Resin transfer moulding, Pultrusion, Injection moulding. Fiber reinforced plastics (FRP), Glass fiber reinforced plastics (GRP).

Ceramic Matrix composites: Ceramic matrix - oxide ceramics, non-oxide ceramics, alumina, silicon nitride. Reinforcements – particles, fibers, whiskers. Sintering - Hot pressing, Cold isostatic pressing, Hot isostatic pressing.

Total = 45 Hours

Reference Books:

1	Raymond Seymour, “An Introduction to Polymer Chemistry”, McGraw-Hill Book Co., New York, USA, 1971.
2	Michel Barsoum, “Fundamentals of Ceramics”, McGraw-Hill Publishing Co. Singapore, 1997.
3	Kingery W.D., “Introduction to Ceramics”, John Wiley, USA, 1960.
4	Mathews F.L. and Rawlings R.D., “Composite materials: Engineering and Science”, Chapman and Hall, London, England, 1st edition, 1994.
5	Chawla K.K., “Composite materials”, Springer – Verlag, 1987.
6	Bhargava. “Engineering Materials- Polymers, Ceramics and Composites”, Prentice Hall of India Ltd., New Delhi.

7	Gowariker V R., Viswanathan N V, Jayadev Sreedhar, "Polymer Science", New Age International Pvt. Ltd., 2005.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Classify the polymers and select different polymer materials for various applications.	L2: Understanding
CO2	:	Illustrate different methods to synthesize polymer materials.	L2: Understanding
CO3	:	Distinguish the structure and properties of different ceramics.	L4:Analysing
CO4	:	Illustrate different methods to synthesize ceramic and glasses.	L2: Understanding
CO5	:	Explain types, synthesis and properties and its applications of PMCs and CMCs.	L3:Applying

COURSE ARTICULATION MATRIX

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	1												1		
CO2	1			1	1								1		
CO3	2		1											1	
CO4		1											1		
CO5	1		1											1	
Avg.	1.3	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	0.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22WTE08	FINITE ELEMENT ANALYSIS		Semester			
PREREQUISITES		**Category**	**PE**	**Credit**		**3**
Engineering Maths		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To provide the basic FEM modeling and to analyze and solve metallurgical problems using those methods.

Unit I	**TWO DIMENSIONAL PROBLEMS**	**9**	**0**	**0**	**9**

Poisson equation – Laplace equation – Weak form – Element matrices for triangular and rectangular elements – Evaluation of integrals – Assembly – Axi-symmetric problems – Applications – Conduction and convection heat transfer – Torsional cylindrical member – Transient analysis - Theory of elasticity – Plane strain – Plane stress – Axi-symmetric problems– Principle of virtual displacement.

Unit II	**ISOPARAMETRIC ELEMENTS AND ITS APPLICATIONS**	**9**	**0**	**0**	**9**

Introduction – Bilinear quadrilateral elements – Quadratic quadrilaterals – Hexahedral elements - Numerical integration – Gauss quadrature – Static condensation – Load considerations – Stress calculations – Examples of 2D and 3D applications.

Unit III	**NON-LINEAR PROBLEMS AND ERROR ESTIMATES**	**9**	**0**	**0**	**9**

Introduction- Iterative Techniques- Material non-Linearity- Elasto Plasticity- Plasticity- Visco plasticity- Geometric Non linearity-large displacement Formulation-Application in Metal Forming Process and contact problems- Error norms and Convergence rates- high refinement with adaptivity- Adaptive refinement.

Unit IV	**DYNAMIC PROBLEM**	**9**	**0**	**0**	**9**

Direct Formulation- Free- Transient and Forced Response- Solution Procedures- Subspace Iterative Technique - Houbolt- Wilson- Newmark - Methods –Examples.

Unit V	**FLUID MECHANICS**	**9**	**0**	**0**	**9**

Governing Equations of Fluid Mechanics-Inviscid and Incompressible Flow- Potential Formulations-Slow Non-Newtonian Flow- Navier Stokes Equation- Steady and Transient Solutions

Total= 45 Hours

Reference Books:

1	Cook, Robert Davis et al “Concepts and Applications of Finite Element Analysis”, Wiley, John & Sons,1981.
2	Desai C.S. and Abel J.F., “Introduction to Finite Element Method”, Affiliated East- West Press, 1972.
3	Chandrupatla, Belagundu, “Finite Elements in Engineering”, Prentice Hall of India Private Ltd., 2002.
4	O.C. Zienkiewicz and R.L. Taylor, Finite element methods Vol I & Vol II, McGraw Hill, 1989, 1992.
5	K.J. Bathe, Finite element procedures, PHI Ltd., 1996.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Demonstrate understanding of FE formulation for axi-symmetric problems in heat transfer and elasticity.	L2: Understanding
CO2	:	Identify the primary and secondary variables of the problem and choose correct nodal degrees of freedom and develop suitable shape functions for an isoparametric element.	L3:Applying
CO3	:	Solve contact problems using non-linear equations of equilibrium.	L4:Analysing
CO4	:	Analyze the dynamic flow problems by iterative methods.	L4:Analysing
CO5	:	Solve non Newtonian Flow-Navier Stokes Equation by FE equations.	L4:Analysing

COURSE ARTICULATION MATRIX

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	1			1									1		
CO2	1	1			1	1							1		
CO3		1		1									1		
CO4				1	1								1		
CO5	1				1								1		
Avg.	1.0	1.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22WTE09	ELECTRICAL ASPECTS OF WELDING		Semester			
PREREQUISITES		Category	PE	Credit		3
Manufacturing technology, Basic Electrical and Electronic Engineering		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To understand the static and dynamic characteristics of electric arc and its associated power characteristics.
2	To gain knowledge on the operating principles of various types of welding power sources.

Unit I	ELECTRICAL CHARACTERISTICS OF WELDING ARC AND POWER SOURCES	9	0	0	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 characteristic- arc length control.

Unit II	WELDING TRANSFORMERS AND ROTATING MACHINES	9	0	0	9

Requirements of welding transformer– types of welding transformer- high reactance- external reactor – integral reactor – saturable reactor – all characteristic- rotating machine – series generator –separately excited- self excited – split pole dc welding generator – out put characteristic – multi operator dc welding generator – duty cycle and simple problems.

Unit III	SOLID STATE WELDING POWER SOURCES	9	0	0	9

Rectification principles – uncontrolled, controlled – 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	0	0	9

Open loop control and close 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 system in welding.

Unit V	ELECTRICAL MEASUREMENTS IN WELDING AND SPECIAL POWER SOURCES	9	0	0	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.

Total = 45 Hours

Reference Books:

1	John Norrish, “Arc Welding processes” - Institute of Physics Publishing Bristol 1992.
2	R.S.Parmar,“Welding Processes and Technology” Khanna Publishers 2nd Ed., 2005.
3	Howard B. Cary “Arc Welding Automations”, Marcel Dekker Inc, Newyork 1995.
4	Md.Ibrahim Khan “Welding Science and Technology, New age International New Delhi 2007.
5	Pan Jiluan “Arc Welding control” CRC Press Washington D.C.2003.
6	The Procedure Handbook of Arc Welding, twelfth Edition, Lincoln Electric, USA, 1973.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Demonstrate the static and dynamic characteristics of electric arc and its associated power characteristics.	L2: Understanding
CO2	:	Choose different transformers and rotating machines for various welding processes.	L3:Applying
CO3	:	Select the right choice of welding power sources for solid state welding processes.	L3:Applying
CO4	:	Recognize and list the wire feed systems and seam tracking devices.	L3:Applying
CO5	:	Discuss various electrical measurements in welding and special power sources.	L2: Understanding

COURSE ARTICULATION MATRIX

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	1			1	2	1							1		
CO2	2	1			1	1							1		
CO3	1	1		1									1		
CO4	1												1		
CO5		1	1										1		
Avg.	1.3	1.0	1.0	1.0	1.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22WTE10	TOTAL QUALITY SYSTEM AND ENGINEERING	Semester	

PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To learn the different techniques of total quality management and the management principles used in engineering and different management systems.
2	To learn the methods of statistical quality control and process capability.

Unit I	INTRODUCTION	9	0	0	9

Principles of Quality Management – Pioneers of TQM –Quality Cost-Quality System- Customer Orientation – Bench marking – Re-engineering - Concurrent Engineering.

Unit II	MANAGEMENT SYSTEMS	9	0	0	9

Leadership – Organizational Structure- Team Building- Information Systems and Documentation –Quality Auditing – Brief overview of ISO 9001:2015, ISO/TS 16949:2014, ISO 14001:2015, OHSAS 18001:2007, ISO 50001:2011.

Unit III	TECHNIQUES OF TQM	9	0	0	9

FMEA, Quality Function Deployment, Quality Circles, KAIZEN, POKA YOKE, Taguchi Methods, 5S, Six Sigma, TPM, Single vendor Concept, J.I.T.

Unit IV	STATISTICAL QUALITY CONTROL	9	0	0	9

Methods and Philosophy of statistical process control –Control Charts for Variables and Attributes–Cumulative sum and Exponential-weighted moving average control charts-other SPC techniques –Process Capability Analysis.

Unit V	ACCEPTANCE SAMPLING	9	0	0	9

Acceptance sampling Problem –Single Sampling Plans for Attributes –Double, Multiple and sequential sampling, Military standards – The Dodge – Romig Sampling plans.

Total = 45 Hours

Reference Books:

1	Mohamed Zairi, “Total Quality Management for Engineers”, Wood head Publishers, 2013.
2	Montgomery Douglas C, “Introduction to Statistical Quality Control”, John Wiley and Sons Inc., New Delhi, 2013.
3	Fiegenbaum. A.V, “Total Quality Control”, Mc Graw Hill Inc., New Delhi, 2008.
4	Eugene Grant et. al, “Statistical Quality Control”, 7thedition, Mc Graw Hill, New Delhi, 2000.

Course Outcomes: Upon completion of this course, the students will be able to:			Bloom’s Taxonomy Mapped
CO1	:	Illustrate quality and cost of the TQM systems.	L2: Understanding
CO2	:	Discuss different quality auditing systems.	L2: Understanding
CO3	:	Explain different techniques and concepts of Total Quality Management.	L2: Understanding
CO4	:	Analyze different Statistical process for quality control.	L4:Analysing
CO5	:	Solve problems on different sampling methods.	L3:Applying

COURSE ARTICULATION MATRIX															
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1						1			1				1		
CO2								1				1	1		
CO3									1						1
CO4						1		1	1						1
CO5							1	1							1
Avg.	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	1.0	0.0	1.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22WTE11	AUTOMATION AND ROBOTS		Semester			
PREREQUISITES		Category	PE	Credit		3
Manufacturing Technology		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To compile and work with the automated equipment and it's processing are Automation of arc welding processes and other related welding processes.
2	To emulate the Automated welding equipment, Arc and work motion and standardized arc welding machines, controls and sensors and gain knowledge on operations using the robots.

Unit I	AUTOMATION OF ARC WELDING PROCESSES	9	0	0	9

Need for automation in welding, introduction to semi-automatic mechanized, automatic, robotic and adaptive control welding. Automatic welding system – factors affecting welding productivity– advantages and disadvantages of welding automation. Arc welding processes suitable for automation and degree of automation possible in different welding processes like GMAW, FCAW, SAW, GTAW, PAW and Stud welding.

Unit II	AUTOMATION OF OTHER RELATED PROCESSES	9	0	0	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 and Plasma cutting, Laser Beam cutting and Thermal spraying.

Unit III	AUTOMATED WELDING EQUIPMENT, ARC AND WORK MOTION DEVICES	9	0	0	9

Welding power sources, type of electrode wire feeders and electrode wire dispersing system spools, coils, rods, drums, pay off packs, typical adaptors and spiders. Types of welding torches used in automated welding and functions of torches. Types of standardized arc motion devices – Tractor, carriages, side beam carriages, manipulators and Gantry carriages. Work motion devices – Universal positioners, turning rolls, head and tail stock positioners. Combination of arc and work motion devices.

Unit IV	STANDARDIZED ARC WELDING MACHINES, CONTROLS AND SENSORS	9	0	0	9

Standardized arc welding equipment, types of standardized welding machines – seamers, welding lathes, weld – around machines, nozzle welders and bore welders. beam welders, strip welders, Laser welding cell and Plasma Transferred Arc Overlay system. Automatic welding of pipes and tubes Introduction to some dedicated automatic welding machines. Temporary portable automated tooling for welding. Controls and sensors for Automated Arc welding.

Unit V	ROBOTIC ARC WELDING	9	0	0	9

Flexible automation of arc welding. Robotic arc welding system, types of welding Robots – Revolute, Cartesian, Spherical, Cylindrical and Scara – Hybrid robots for welding, features of a welding robot, robotic part – holding positioners, Teaching the robot, Specifying the welding robot. Some case studies of robotic welding applications.

Total = 45 Hours

Reference Books:

1	Howard B. Cary "Arc welding Automation"- Marcel Dekker, New York,1995
2	AWS Welding Handbook, Vol. 3, 9th edition, A W S., 2015.
3	AWS Welding Handbook, vol.5, "Engineering Costs, Quality and Safety", 9th edition, AWS, 2015.
4	The Procedure Handbook of Arc Welding, 13th Edition, Lincoln Electric, USA, 1994.
5	Proceedings of the International Conference on Assembly Automation, British Welding Institute, 1985.
6	Kozyrev, Industrial Robots Handbook, Mir Publishers, Moscow, 1985.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Demonstrate the automation of the arc welding processes.	L2: Understanding
CO2	:	Demonstrate the automation of other the welding and related processes.	L4:Analysing
CO3	:	Discuss different automated welding equipments, arc and work motions devices.	L2: Understanding
CO4	:	Explain the standardized arc welding machines, controls and sensors.	L2: Understanding
CO5	:	Apply the Robotic Arc welding for different functions of robot system.	L3: Applying

COURSE ARTICULATION MATRIX

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	1												1		
CO2	2	1											1		
CO3	2	1											2		
CO4	1			1	1									1	
CO5	1														1
Avg.	1.4	1.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	1.0	1.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22WTE12	WELDING APPLICATION TECHNOLOGY	Semester			
PREREQUISITES	**Category**	**PE**	**Credit**		**3**
Manufacturing Technology	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Learning Objectives

1	To understand the materials, Process, fabrication techniques used in welding of structural, pressure vessels, storage tank, piping and pipelines, chemical plants and cryogenics.
3	To gain knowledge of the materials, processes, fabrication, inspection and stringent quality control procedures used for shipyards, railways, aerospace and automobiles.

Unit I	**WELDING OF STRUCTURALS AND PRESSURE VESSELS**	**9**	**0**	**0**	**9**

STRUCTURALS: Types of structural elements and their welding, materials used in bridges and welding of bridges.
PRESSUREVESSELS: Material selection and factors affecting it, fabrication of conventional pressure vessels– welding processes used, nozzle welding, tube to tube plate welds, flanges, vessel ends, fabrication of clad pressure vessels. Weldability aspects of pressure vessel steels.

Unit II	**WELDING OF STORAGE TANKS AND PIPINGS**	**9**	**0**	**0**	**9**

STORAGE TANKS: Welding of vertical storage tanks and Horton sphere.
PIPING AND PIPELINES: pipe steels and electrodes, types of joints and welding, backing welds rings, fittings, alloys used for piping, pipe welding procedures, preheating and PWHT, offshore pipework, pipelines and pipeline welding, under water pipeline welding.

Unit III	**WELDINGIN CHEMICAL PLANTS, CRYOGENICS & MICRO JOINING TECHNIQUES**	**9**	**0**	**0**	**9**

CHEMICAL PLANTS: Welding of oil-refinery components and fertilizer plant components.
CRYOGENICS: Materials used for cryogenic applications, problems of welding. Welding processes and procedures used for welding cryogenic materials.
MICRO JOINING TECHNIQUES: Various techniques used for joining of electronic circuits and other micro joining applications**.**

Unit IV	**WELDING OFSHIP STRUCTURE AND RAILWAYS**	**9**	**0**	**0**	**9**

SHIP STRUCTURE: Main parts of ship structure, materials for ship building, unit and block method of ship construction, welding of submarine steels, welding of offshore structures.
RAILWAYS: Materials used for locomotive subassemblies, rail coaches, wagons and its sub-assemblies, rails and welding process used.

Unit V	**WELDING OF AEROSPACE AND AUTOMOBILE**	**9**	**0**	**0**	**9**

AEROSPACE: Main parts of aerospace structure, materials for aircrafts building, method of aircraft construction, welding of aircraft structures.
AUTOMOBILE: Main parts in Automobiles, Materials used for automobile subassemblies, welding of automobile components.

Total = 45 Hours

Reference Books:

1	S.V. Nadkarni, "Modern Arc Welding Technology", Oxford-IBH Publishers, New Delhi, 7th edition 1996.
2	R.S. Parmar, "Welding Engineering and Technology", Khanna Publishers, New Delhi, 1st edition 1997.
3	AWS Welding Handbook, Sec.5 – Applications of Welding, 5tn Edition, 1967.
4	AWS Welding Handbook, Vol.4, 7tn Edition, 1991.
5	ASM Metals Handbook, Vol.6, Welding, Brazing and Soldering, ASM, New York, 1998.

6	Howard B. Cary, "Modern Welding Technology", Prentice Hall, New Jersey, USA, 1989.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Select the suitable welding procedures for the fabrication of structural elements and conventional pressure vessels and solve the difficulties in welding of pressure vessel steels.	L2: Understanding
CO2	:	Choose the correct materials, electrodes, type of joint, welding processes and fittings for the fabrication of storage tanks, piping as well as pipelines.	L4:Analysing
CO3	:	Solve the problems involved in welding of oil refinery components, fertilizer components and cryogenic materials.	L4:Analysing
CO4	:	Demonstrate the shipbuilding activities and solve the problems involved in welding of submarine steels and railway materials.	L3:Applying
CO5	:	Discuss materials for Aerospace and Automobile components and their weldments.	L3:Applying

COURSE ARTICULATION MATRIX

CO/PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1				1		1						1		
CO2	2	1		1											1
CO3	1	2			1								1		
CO4	1					1							1		
CO5	1														1
Avg.	1.2	1.5	0.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22WTE13	BRAZING, SOLDERING, SURFACING AND CUTTING	Semester	

PREREQUISITES	Category	PE	Credit		3
Manufacturing Technology	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To understand the fundamental concepts, applications, advantages and limitations of brazing, soldering, surfacing and cutting.

Unit I	FUNDAMENTALS OF BRAZING AND SOLDERING	9	0	0	9

Wetting and spreading characteristics, surface tension and contact angle concepts. Filling of horizontal and vertical capillary joints. Capillary dams

Unit II	FLUXES AND ATMOSPHERES FOR BRAZING AND SOLDERING	9	0	0	9

Role of flux and characteristics constituents of flux, grouping and applications Fluxes used for specific braze metal flux removal and related corrosion problem. Atmosphere for brazing and atmosphere for brazing specific base metal Metallurgy of filler metal for brazing and soldering. Joint design and fixturing for brazing.

Unit III	SOLDERING AND BRAZING PROCESSES	9	0	0	9

Hand soldering, flame soldering furnace soldering, hot gas blanket soldering, wave soldering, etc., torch brazing furnace brazing, induction brazing, dip brazing resistance brazing, vaccum brazing, etc., applications of brazing soldering-brazing and soldering defects.

Unit IV	SURFACING	9	0	0	9

Thermal spraying, plasma spraying, laser surface alloying and modification. Surfacing spraying to improve wear resistance and corrosion resistance. CVD, PVD and ion implantation. Cladding and its applications.

Unit V	THERMAL CUTTING PROCESSES	9	0	0	9

Oxygen cutting- oxyfuel gas, metal powder, chemical flux and oxygen arc cutting. Arc cutting processes- carbon arc, air carbon arc cutting. Metal and plasma arc cutting, High energy beam cutting, laser beam cutting, water jet cutting and under water cutting.

Total = 45 Hours

Reference Books:

1	Schwartz. M., “Brazing – for the Engineering Technologies”, Champan and Hall, 1995.
2	Manko. H.H., “Solders and Soldering”.2nd Edition, McGraw Hill, 1979.
3	Udin, Funk, and Wulf., “Welding for Engineers”.
4	ASM Metals Hand Book Vol. 6 “Welding and Brazing”, 1988.
5	Lancaster .J .F. “Metallurgy of Welding, Brazing and Soldering” 3rd edition. George Allen & Unwin, 1980.
6	Brooke, “ Indusrial Brazing”, Bcton.1975.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Explain the concepts of brazing and soldering.	L2: Understanding
CO2	:	Identify suitable fluxes, atmosphere and filler metals used for brazing and soldering.	L3:Applying
CO3	:	Identify different type of brazing and soldering for various applications.	L3:Applying
CO4	:	Explain different types of surfacing techniques.	L2: Understanding
CO5	:	Discuss the various thermal cutting processes.	L2: Understanding

COURSE ARTICULATION MATRIX

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	1			1	1								1		
CO2	1													1	
CO3	2		1			1	1						1		1
CO4		1											1		
CO5	1	1											1		
Avg.	1.3	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22WTE14	CORROSION AND SURFACE ENGINEERING		Semester			
PREREQUISITES		Category	PE	Credit		3
Engineering materials and Metallurgy		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To provide a practical knowledge about corrosion and surface engineering, with its application in engineering field.

Unit I	**MECHANISMS AND TYPES OF CORROSION**	**9**	**0**	**0**	**9**

Principles of direct and Electro chemical Corrosion, Hydrogen evolution and Oxygen absorption mechanisms – Galvanic corrosion, Galvanic series-specific types of corrosion such as uniform, Pitting, Intergranular, Cavitations, Crevice Fretting, Erosion and Stress Corrosion –Factors influencing corrosion.

Unit II	**TESTING AND PREVENTION OF CORROSION**	**9**	**0**	**0**	**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 –Modifications of corrosive environment –Inhibitors – Cathodic Protection – Protective surface coatings.

Unit III	**CORROSION BEHAVIOR OF MATERIALS**	**9**	**0**	**0**	**9**

Corrosion of steels, stainless steel, Aluminum alloys, copper alloys, Nickel and Titanium alloys- corrosion of Polymers, Ceramics and Composite materials.

Unit IV	**SURFACE ENGINEERING FOR WEAR AND CORROSION RESISTANCE**	**9**	**0**	**0**	**9**

Diffusion coatings –Electro and Electro less Plating –Hot dip coating –Hard facing-Metal spraying, Flame and Arc processes- Conversion coating –Selection of coating for wear and Corrosion resistance.

Unit V	**THIN LAYER ENGINEERING PROCESSES**	**9**	**0**	**0**	**9**

Laser and Electron Beam hardening –Effect of process variables such as power and scan speed - Physical vapor deposition, Thermal evaporation, Arc vaporization, Sputtering, Ion plating - Chemical vapor deposition – Coating of tools, TiC, TiN, Al_2O_3 and Diamond coating Properties and applications of thin coatings.

Total = 45 Hours

Reference Books:

1	Fontana. G., Corrosion Engineering, McGraw Hill, 1985.
2	Kenneth G. Budinski, Surface Engineering for Wear Resistance, Prentice hall, 1992.
3	ASM Metals Hand Book –Vol. 5, Surface Engineering, 1996.
4	Denny A Jones, “Principles and prevention of corrosion”, 2nd edition, Prentice Hall, New Jersey, 1995.
5	ASM International, Surface Engineering for Corrosion and Wear Resistance, 2005.
6	Schweitzer. P.A., Corrosion Engineering Hand Book, 3rd Edition, Marcel Decker, 1996.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Classify different types of corrosion and explain their mechanisms.	L2: Understanding
CO2	:	Estimate corrosion resistance by different tests.	L4:Analysing
CO3	:	Understand corrosion behaviour of different metals at different conditions.	L2: Understanding
CO4	:	Define different forms of processing techniques of surface engineering materials.	L2: Understanding
CO5	:	Apply different types of deposition and spraying techniques of thin layer applications.	L3:Applying

COURSE ARTICULATION MATRIX

CO/PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1					1	1								1
CO2	1	1		1									1		
CO3	2		1		1									1	
CO4	1				1								1		
CO5	1												1		
Avg.	1.2	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22WTE15	DESIGN OF WELDMENTS		Semester			
PREREQUISITES		Category	PE	Credit		
Manufacturing Technology		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To design a system, a component, or a process to meet desired needs within realistic constraints such as design basics, weld design for static loading, weld design for dynamic loading, distortion and residual stresses and failure analysis of the manufacturing.

Unit I	**DESIGN BASICS**	**9**	**0**	**0**	**9**

Types of joints, Types of welds, variants of joints, selection of weld type, weld joints for structural tubular connections, welding symbols, weld dimensions, NDT symbols. Principles of weld joint design – General and specific design principles.

Unit II	**WELD DESIGN FOR STATIC LOADING**	**9**	**0**	**0**	**9**

Material or section properties, Weld design stress calculation for welds, design under different types of loading like tension, compression, bending, shear, torsion and shock.

Unit III	**WELD DESIGN FOR DYNAMIC LOADING**	**9**	**0**	**0**	**9**

Basic details of fatigue and fatigue failure, S-N curve, Goodman diagram, factors affecting fatigue life of welded joint, methods of improving fatigue life of welded structures, design for fatigue loading, weld design using fracture toughness value (KIC).

Unit IV	**DISTORTION AND RESIDUAL STRESSES**	**9**	**0**	**0**	**9**

Welding residual stresses – causes, occurrence, effects–thermal and mechanical relieving. Types of distortion – factors affecting distortion –distortion control methods – prediction- correction, jigs, fixtures and positioners.

Unit V	**FAILURE ANALYSIS IN DESIGN ASPECTS**	**9**	**0**	**0**	**9**

Failure analysis–methodology, approaches, tools and techniques of failure analysis, modes of failure, failure data retrieval, procedural steps for investigation of a failure for failure analysis. Case studies in design of weldments.

Total = 45 Hours

Reference Books:

1	Blodgett. O. W., Design of Weldments, James F. Lincoln Arc Welding Foundation, 1991.
2	R.S.Parmar, Welding Engineering and Technology 2nd edition, 2010.
3	Gurney T.R. Fatigue of Welded Structures. Cambridge University Press, 1980.
4	Rolfe. T., Barsom. J., Fracture and Fatigue Control of Structures – Applications of Fracture Mechanics, Prentice Hall, 1987.
5	ASM Metals Hand Book. Failure Analysis and Prevention. Vol. 11. ASM 2002.
6	Das, A.K., Metallurgy of Failure Analysis, Tata McGraw Hill, New Delhi, 1997.
7	Donald J. Wulpi, Understanding how components fail, ASM International, 3rd Edition, 2013.
8	Colangelo. V.J. and Heiser. F.A., "Analysis of Metallurgical Failures", John Wiley and Sons Inc. New York, USA,1987.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Explain the design basics of the different welding operations.	L2: Understanding
CO2	:	Choose suitable weld design for static loading processes.	L3:Applying
CO3	:	Select suitable weld design for dynamic loading processes.	L3:Applying
CO4	:	Illustrate the factors influencing the distortion and residual stresses.	L2: Understanding
CO5	:	Distinguish various types of weldment failures.	L4: Analysing

COURSE ARTICULATION MATRIX

CO/PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1												1		1
CO2	1		1	1									1		
CO3	2	1	2		1								1		
CO4	1		1												1
CO5	1		1												1
Avg.	1.2	1.0	1.3	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22WTE16	INDUSTRIAL SAFETY	Semester	

PREREQUISITES	Category	PE	Credit		3
Manufacturing Technology	Hours/Week	L	T	P	TH
		3	0	0	3

Unit I	INDUSTRIAL SAFETY	9	0	0	9

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc., Safety color codes. Fire prevention and firefighting, equipment and methods.

Unit II	FUNDAMENTALS OF MAINTENANCE ENGINEERING	9	0	0	9

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Unit III	WEAR AND CORROSION AND THEIR PREVENTION	9	0	0	9

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

Unit IV	FAULT TRACING	9	0	0	9

Fault tracing- concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

Unit V	PERIODIC AND PREVENTIVE MAINTENANCE	9	0	0	9

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexitiesanditsuse,definition,need,stepsandadvantagesofpreventivemaintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

Total = 45 Hours

Reference Books:

1	Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2	Maintenance Engineering, H. P. Garg, S. Chand and Company.
3	Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4	Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Discuss the safety rules & regulations, standards & codes applicable for engineering industry.	L2: Understanding
CO2	:	Analyse fundamentals of maintenance and industrial safety	L4: Analysing
CO3	:	Apply the principles wear and corrosion for different industry.	L3:Applying
CO4	:	Analyse fault tracing system of various machineries.	L4: Analysing
CO5	:	Elaborate various periodic and preventive maintenance activities in industry	L2: Understanding

COURSE ARTICULATION MATRIX

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	1												1		
CO2	1												1		
CO3	2	1		1										1	
CO4	1		1		1	1									1
CO5	1		1				1								1
Avg.	1.2	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22WTE17	WELDING CODES AND STANDARDS		Semester			
PREREQUISITES		Category	PE	Credit		3
Manufacturing Technology		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	Over view and Introductory treatment of codes and standards in the reference – Numerical problems, written document procedures and qualification.
2	To acquire knowledge on various welding codes and standards related to various engineering applications.

Unit I	**STRUCTURAL WELDING CODES**	**9**	**0**	**0**	**9**
Design requirements, allowable stress values, workmanship and inspection, introduction to welding codes and standards.					
Unit II	**PETROLEUM PIPING FABRICATION**	**9**	**0**	**0**	**9**
Process and product standards for manufacturing of pipe – welding procedure and welder qualifications, field welding and inspection, API 1104 and API 5L.					
Unit III	**PRESSUR EVESSELF ABRICATION**	**9**	**0**	**0**	**9**
Design requirements fabrication methods, joint categories, welding and inspection, post weld heat treatment and hydro testing.					
Unit IV	**WELDING PROCEDURE AND WELDER QUALIFICATION**	**9**	**0**	**0**	**9**
Welding procedure specification, procedure qualification records, performance qualification, variables.					
Unit V	**MATERIALS AND CONSUMABLES**	**9**	**0**	**0**	**9**
Introduction to materials standards and testing of materials, consumables testing and qualification as per ASME/AWS requirements.					

Total = 45 Hours

Reference Books:

1	AWS D1.1 Structural Welding Code
2	API 1104
3	ASME Section VIII – Division 1
4	ASME Section IX
5	ASME Section II Part A and C
6	API6A

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Identify various design requirements and applicability of AWS D1.1.	L4:Analysing
CO2	:	Apply API 1104 and AP15L for pipe welding applications	L3:Applying
CO3	:	Apply ASME II, V, VIII and IX for boiler fabrication.	L3:Applying
CO4	:	Apply WPS, PQR and performance qualification variables for a specific welding application.	L3:Applying
CO5	:	Discuss suitability of different materials based on standard, testing methods and consumable testing.	L2: Understanding

COURSE ARTICULATION MATRIX

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	1												1		
CO2	2		1	1			1						1		1
CO3	1	2			1	1									1
CO4	1												1	1	
CO5	1													1	
Avg.	1.2	2.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22WTE18	FOUNDRY PROCESSES AND METALLURGY		Semester			
PREREQUISITES		Category	PE	Credit		3
Manufacturing Technology, Engineering materials and Metallurgy		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To know the basic concept of metal casting technology.
2	To apply the concept to produce new materials.

Unit I	**MOULDING MATERIALS AND PATTERNS**	**9**	**0**	**0**	**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.

Unit II	**MOULDING AND CASTING TECHNIQUES**	**9**	**0**	**0**	**9**

Sand moulding: green sand moulding, dry sand moulding, skin dry sand moulding, shell moulding, carbon di-oxide process, permanent mould casting, die casting, centrifugal casting, plaster mould casting, investment casting, squeeze casting, full mould process, Rheo casting, Thixo casting.

Unit III	**DESIGN OF CASTINGS**	**9**	**0**	**0**	**9**

Elements of gating system, types, design of gating system with examples, functions of risers, types of risers, Chvorinov's rule, design and positioning of riser with examples, use of chills, exothermic compounds etc., riser efficiency, yield calculations. Use of softwares for foundry applications

Unit IV	**QUALITY CONTROL, FETTLING, INSPECTION AND AUTOMATION**	**9**	**0**	**0**	**9**

Quality control: composition control in steels and cast irons. Simple problems on charge calculations. Cleaning and repair of castings. Casting defects and remedies. Heat treatment of castings. Inspection of casting. Principles of mechanisation, automation and foundry layout. Sand reclamation and Pollution control in foundries.

Unit V	**FOUNDRY METALLURGY**	**9**	**0**	**0**	**9**

Melting practice and Metallurgy of steels, alloy steels, cast irons, aluminium alloys, copper alloys and magnesium alloys, Solidification of Castings, Fluidity, Definition, Factors affecting and Measurement of Fluidity, inoculation in cast irons, modification in Al-Si system, Slag-Metal Reactions , Gases in Metals and Degassing Technique.

Total = 45 Hours

Reference Books:

1	Heine R W., Loper, C.R. Rosenthal, P.C., "Principles of Metal Casting" ,Tata-McGraw Hill Publishing Co Ltd, New Delhi, 2011.
2	Jain P.L ,"Principles of Foundry Technology", Tata McGraw Hill Publishing Co Ltd, New Delhi,

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Explain the moulding materials, types of pattern and allowances in foundry operations.	L2: Understanding
CO2	:	Discuss various casting techniques.	L2: Understanding
CO3	:	Apply various design aspects for different casting techniques.	L3:Applying
CO4	:	Describe the quality control, fettling, inspection and automation of casting engineering.	L2: Understanding
CO5	:	Apply the melting procedure for the various alloys like steels, stainless steels, Discuss the slag-metal reactions.	L3:Applying

COURSE ARTICULATION MATRIX

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	1					1							1		
CO2	1				1								1		
CO3		1	1	1											1
CO4	1				1										1
CO5	1					1	1							1	
Avg.	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22WTE19	FORMING PROCESSES		Semester			
PREREQUISITES		Category	PE	Credit		3
Manufacturing Technology, Engineering materials and Metallurgy		Hours/Week	L	T	P	TH
			3	0	0	3

Unit I	FUNDAMENTALS OF METAL FORMING	9	0	0	9

Yield criteria: Von Mises, Tresca yield criteria. Comparison of yield criteria, Octahedral shear stress and shear strain- Forming load calculations. Fundamentals of metal forming: Flow stress determination, Temperature in metal forming, Hot, Cold and Warm working, Strain rate effects, Metallurgical structures, friction and lubrication, Residual stresses.

Unit II	FORGING AND ROLLING	9	0	0	9

Forging: Forging-types of presses and hammers, Classification, Open die forging - Forging of disks - Closed die forging - Die design, Calculation of forging loads - Defects, causes and remedies. Rolling: Rolling of Blooms, billets, slabs and sheet, types of rolling mills. Forces and geometrical relationship in rolling. Analysis of rolling load. Defects causes and remedies.

Unit III	EXTRUSION AND DRAWING	9	0	0	9

Extrusion: Direct and Indirect extrusion, equipments, container less extrusion port hole extrusion die, hydrostatic extrusion, defects and remedies. Analysis of extrusion, tube extrusion and production of seamless pipe and tube. Hydrostatic extrusion. Equal Channel Angular Extrusion. Defects causes and remedies, Drawing of rods, wires and tubes. Introduction to Super plasticity.

Unit IV	SHEET METAL WORKING AND HIGH VELOCITY FORMING	9	0	0	9

Sheet Metal Forming: Bending, spinning, stretch forming, deep drawing. Cutting methods - Shearing, blanking, Punching. Defects and applications. High velocity forming methods: Explosive forming, Electro hydraulic, Magnetic pulse forming and pneumatic method, Dynapak method. Formability tests: Effect of strain hardening coefficient (n value), strain rate sensitivity (m value), plastic strain ratio (r value) on formability. Introduction to formability limit diagram.

Unit V	POWDER METALLURGY	9	0	0	9

Steps in P/M, advantages and disadvantages. Powder production methods-physical, chemical and mechanical methods. Compaction-Pressure and pressure-less compaction techniques. Hot and Cold isostatic pressing, Sintering- solid state and liquid phase sintering. Microwave sintering, Typical applications.

Total = 45 Hours

Reference Books:

1	Dieter, G.E., Mechanical Metallurgy, McGraw Hill Co, SI Edition, 1995.
2	ASM Metals Handbook, Vol.14, Forming and Forging, Metals Park, Ohio, USA, 2001.
3	Sinha, A.K., Powder Metallurgy, Dhanpat Rai and Sons, New Delhi, 1992.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Describe the various fundamentals aspects of metal forming processes.	L2: Understanding
CO2	:	Explain the knowledge in forging and rolling processes.	L2: Understanding
CO3	:	Explain the extrusion and drawing processes, defects and it remedies.	L2: Understanding
CO4	:	Apply the fundamentals of various sheet metals forming process for different sheet components.	L3:Applying
CO5	:	Apply the concepts of power metallurgy for densification of components.	L3:Applying

COURSE ARTICULATION MATRIX

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	1		1										1		1
CO2	1	1		1	1								1		
CO3	1												1		
CO4	1												1		
CO5	1												1	1	
Avg.	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

AUDIT COURSES

22AC01	ENGLISH FOR RESEARCH PAPER WRITING	SEMESTER I & II

PREREQUISTIES	CATEGORY	AC	Credit		
		L	T	P	TH
Basic skill in paper writing on a particular topic	Hours/Week	2	0	0	2

COURSE OBJECTIVES

1.	To help the learners to realize the necessity of English in writing a Research paper
2.	To enable the learners to write different sections of a research paper
3.	To train the learners to become better writers of research papers

UNIT I		**6**	**0**	**0**	**0**
Research paper and its importance, Structure of a research paper, Planning and preparation.					
UNIT II		**6**	**0**	**0**	**0**
English in research papers, Basic word order, Collocation, Being concise, Redundancy, Common errors.					
UNIT III		**6**	**0**	**0**	**0**
Key factors that determine the style of a paper, Journal's background, Passive form, Right tense forms, Cohesion and coherence.					
UNIT IV		**6**	**0**	**0**	**0**
Hedging and criticizing, Paraphrasing, Plagiarism, Ensuring quality of the paper and Useful phrases.					
UNIT V		**6**	**0**	**0**	**0**
Key skills in writing Title, Abstract, Introduction, Review of Literature, Discussion and Conclusion, Highlighting findings.					
Total (30L+0T) = 30 Periods					

REFERENCE BOOKS:

1.	Adrian Wallwork, "English for Writing Research Papers," Springer New York Dorecht Heidelberg London, 2016
2.	Howe, Stephen. "Phrase Book for Writing papers and Research in English," Cambridge University Press, 2012.
3.	Goldbort R. "Writing for Science," Yale University press, 2006.
4	Gabor L Lovei. "Writing and Publishing Scientific Paper," Open Book Publishers, 2021

REFERENCES:

1.	R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2.	Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.

COURSE OUTCOMES: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	understand and appreciate the role of English in writing a good research paper	L2: Understanding
CO2	:	apply their knowledge in writing a research paper	L3: Applying
CO3	:	analyze and assess the quality of their research paper	L4: Analyzing

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	0	2	0	0	0	0	2	3	0	1	0	0	0	0	1
CO2	0	3	0	0	0	0	1	3	0	1	0	0	0	0	2
CO3	0	2	0	0	0	0	1	3	0	1	0	0	0	0	1
Avg	0	2.3	0	0	0	0	1.3	3	0	1	0	0	0	0	1.3
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22AC02	DISASTER MANAGEMENT	SEMESTER I / II

PREREQUISITE	CATEGORY	AC	Credit		0
	Hours/Week	L	T	P	TH
		2	0	0	2

Course Objectives:

To have a critical understanding of key concepts in 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 - DISASTER PRONE AREAS IN INDIA	4	0	0	0

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; Areas 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	4	0	0	0

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	4	0	0	0

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	4	0	0	0

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	4	0	0	0

Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

Total (20L+0T)= 20 Periods

COURSE OUTCOMES

On completion of the course, the students will be able to

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

COURSE ARTICULATION MATRIX

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

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22AC03	SANSKRIT FOR TECHNICAL KNOWLEDGE	SEMESTER I / II

PREREQUISITE	CATEGORY	AC	Credit		0
	Hours/Week	L	T	P	TH
		2	0	0	2

Course Objectives:

To get a working knowledge in illustrious Sanskrit, the scientific language in the world. Learning of Sanskrit to improve brain functioning. Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature.

Unit I		**8**	**0**	**0**	**0**
Alphabets in Sanskrit-Past/Present/Future Tense-Simple Sentences					
Unit II		**8**	**0**	**0**	**0**
Order-Introduction of roots-Technical information about Sanskrit Literature					
Unit III		**8**	**0**	**0**	**0**
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics					

Total (24L+0T)= 24 Periods

REFERENCE BOOKS:

1.	Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2.	"Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3.	India"s Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi

COURSE OUTCOMES

On completion of the course, the students will be able to

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

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1					1	1	1	1	1	1	1	1			
CO2					1	1	1	1	1	1	1	1			
CO3					1	1	1	1	1	1	1	1			
Avg					1	1	1	1	1	1	1	1			

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22AC04	VALUE EDUCATION	SEMESTER I / II

PREREQUISITE	CATEGORY	AC	Credit	0

	Hours/Week	L	T	P	TH
		2	0	0	2

Course Objectives:

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	4	0	0	0

Values and self-development – Social values and individual attitudes - Work ethics, Indian vision of Humanism Moral and non-moral valuation - Standards and principles - Value judgements.

Unit II	6	0	0	0

Importance of cultivation of values - Sense of duty-Devotion - Self-reliance – Confidence – Concentration – Truthfulness – Cleanliness – Honesty – Humanity -Power of faith - National Unity – Patriotism - Love for nature – Discipline

Unit III	6	0	0	0

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	6	0	0	0

Character and Competence – Holy books vs Blind faith - Self-management and Good health -Science of reincarnation-Equality – Nonviolence – Humility - Role of Women - All religions and same message - Mind your Mind - Self-control – Honesty - Studying effectively

Total (22L+0T)= 22 Periods

Course Outcomes

On completion of the course, the students will be able to

CO1	:	Knowledge of self-development
CO2	:	Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives
CO3	:	Learn the importance of Human values
CO4	:	Developing the overall personality

Suggested Reading:

1. Chakraborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi,1998.

COURSE ARTICULATION MATRIX

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

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22AC05	CONSTITUTION OF INDIA	SEMESTER I / II

PREREQUISITE	CATEGORY	AC	Credit		0
	Hours/Week	L	T	P	TH
		2	0	0	2

COURSE OBJECTIVES:

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 THE INDIAN CONSTITUTION	4	0	0	0

History, Drafting Committee, (Composition & Working)

Unit II	PHILOSOPHY OF THE INDIAN CONSTITUTION	4	0	0	0

Preamble, Salient Features

Unit III	CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES	4	0	0	0

Fundamental rights, right to equality, right to freedom, right against exploitation, right to freedom of religion, cultural and educational rights, right to constitutional remedies, directive principles of state policy, fundamental duties

Unit IV	ORGANS OF GOVERNANCE	4	0	0	0

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	4	0	0	0

Districts administration head: role and importance, municipalities: introduction, mayor and role of elected representative, CEO of municipal corporation. Panchayati raj: introduction, PRI: zilapanchayat. Elected officials and their roles, CEO zilapanchayat: 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	4	0	0	0

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

Total (24L+0T)= 24 Periods

Suggested Reading:

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., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Outcomes:

Upon completion of this course, the students will be able to:

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.

COURSE ARTICULATION MATRIX

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

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22AC06	PEDAGOGY STUDIES	SEMESTER I / II

PREREQUISTE	CATEGORY	AC	Credit		0
	Hours/Week	L	T	P	TH
		2	0	0	2

Course Objectives:

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	4	0	0	0

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	2	0	0	0

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.

Unit III	4	0	0	0

Evidence on the effectiveness of pedagogical practices, 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	4	0	0	0

Professional development: 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	2	0	0	0

Research gaps and future directions, Research design, Contexts, pedagogy, teacher education, curriculum and assessment, dissemination and research impact

Total (16L+0T)= 16 Periods

Suggested Reading:

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 maths 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:

Upon completion of this course, the students will be able to:

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?

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1					1	1	1	1	1	1	1	1			
CO2					1	1	1	1	1	1	1	1			
CO3					1	1	1	1	1	1	1	1			
Avg					1	1	1	1	1	1	1	1			

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22AC07	STRESS MANAGEMENT BY YOGA	SEMESTER I / II

PREREQUISITE	CATEGORY	AC	Credit		0
	Hours/Week	L	T	P	TH
		2	0	0	2

Course Objectives:

To achieve overall health of body and mind, To overcome stress

Unit I	8	0	0	0

Definitions of Eight parts of yoga.

Unit II	8	0	0	0

Yam and Niyam. Do`s and Don"t"s in life. 1.Ahinsa, satya, astheya, bramhacharya and aparigraha 2.Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

Unit III	8	0	0	0

Asan and Pranayam 1. Various yog poses and their benefits for mind & body 2. Regularization of breathing techniques and its effects-Types of pranayama

Total (24L+0T)= 24 Periods

Suggested Reading:

1. Yogic Asanas for Group Tarining-Part-I" :Janardan Swami Yogabhyasi Mandal, Nagpur " Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

Course Outcomes:

Upon completion of this course, the students will be able to:

CO1	:	Develop healthy mind in a healthy body thus improving social health.
CO2	:	Improve efficiency

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1					1	1	1	1	1	1	1	1			
CO2					1	1	1	1	1	1	1	1			
Avg					1	1	1	1	1	1	1	1			

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)

22AC08	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	SEMESTER I/ II

PREREQUISTE	CATEGORY	AC	Credit		0
	Hours/Week	L	T	P	TH
		2	0	0	2

Course Objectives:

To learn to achieve the highest goal happily, To become a person with stable mind, pleasing personality and determination, To awaken wisdom in students.

Unit I	NEETISATAKAM - HOLISTIC DEVELOPMENT OF PERSONALITY	8	0	0	0

Verses- 19, 20, 21, 22 (wisdom)
Verses- 29, 31, 32 (pride & heroism)
Verses- 26, 28, 63, 65 (virtue)
Verses- 52, 53, 59 (dont‟s)
Verses- 71, 73, 75, 78 (do‟s)

Unit II	APPROACH TO DAY TO DAY WORK AND DUTIES	8	0	0	0

ShrimadBhagwadGeeta:
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, 46, 48.

Unit III	STATEMENTS OF BASIC KNOWLEDGE	8	0	0	0

Shrimad Bhagwad Geeta:
Chapter2-Verses 56, 62, 68
Chapter 12 -Verses 13, 14, 15, 16,17, 18
Personality of Role model.
Shrimad Bhagwad Geeta:
Chapter2-Verses 17,
Chapter 3-Verses 36,37,42
Chapter 4-Verses 18, 38,39
Chapter18 – Verses 37,38,63

Total (24L+0T)= 24 Periods

Suggested Reading:

1. "Srimad Bhagavad Gita" by Swami Swarupan and a Advaita Ashram (Publication Department), Kolkata.
2. Bhartrihari‟s Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

Course Outcomes:

Upon completion of this course, the students will be able to:

CO1	:	Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
CO2	:	The person who has studied Geeta will lead the nation and mankind to peace and prosperity
CO3	:	Study of Neetishatakam will help in developing versatile personality of students.

COURSE ARTICULATION MATRIX

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1					1	1	1	1	1	1	1			
CO2					1	1	1	1	1	1	1			
CO3					1	1	1	1	1	1	1			
Avg					1	1	1	1	1	1	1			

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)