ANNAMALAI UNIVERSITY

Annamalainagar

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MANUFACTURING ENGINEERING

M.E. Welding Engineering

Choice Based Credit System

(Full – Time & Part - Time)

2019

DEPARTMENT OF MANUFACTURING ENGINEERING

M.E. WELDING ENGINEERING

VISION

To prepare students to be life-long learners and global citizens with successful careers in design, research, development, and management of systems in manufacturing and service organizations

MISSION

- A curriculum and educational experience designed and continuously improved through involvement and contribution of students, faculty, administrators, staff, and industry
- A well-focused research program funded at the local, regional , and national level
- A demonstrated competence and expertise in addressing the needs of industry and community at large

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

1. The graduates acquire ability to create model, design, synthesize and analyze essential welding skills, mechanism and automation system.

2. The graduates use their talent, self-confidence, knowledge and engineering practice which facilitate them to presume position of scientific and/or managerial leadership in their career paths.

3. The graduates will adopt ethical attitude and exhibit effective skills in communication management team work and leader qualities.

4. The graduates apply their consciousness of moral, professional responsibilities and motivation to practice life-long learning in a team work environment.

M.E. WELDING ENGINEERING

PROGRAM OUTCOMES (PO)

Upon Completion of the two years of the Master of Welding Engineering Degree,

PO1: ASSIMILATION OF KNOWLEDGE

Acquire fundamental knowledge and understanding of welding processes and materials.

PO2: INTEGRATION OF KNOWLEDGE

Apply knowledge of materials to prescribe appropriate welding technique for specific applications;

PO3: USE OF MODERN TOOLS AND TECHNIQUES

Model and simulate welding processes to conduct experiments and analyze the performance using modern tools;

PO4: ETHICAL PRACTICES AND SOCIAL RESPONSIBILITIES

Understand the environmental issues related to each welding methods and try to develop 'green and clean welding' methods.

PO5: DESIGN AND DEVELOPMENT OF SOLUTIONS

Formulate relevant research problems; conduct experimental and/or analytical work and analyzing results using modern mathematical and scientific methods.

PO6: COLLABORATIVE AND MULTIDISCIPLINARY APPROACH

Design and validate technological solutions to defined problems and write clearly and effectively for the practical utilization of their work by interacting with the engineering community and with society at large, regarding intricate engineering activities on technical perspectives and emerge as an efficient motivator.

PO7: PROJECT MANAGEMENT

Design and develop innovative / manufacturable / marketable/ environmental friendly products useful to the society and nation at large. Graduate will be able to manage any organization well and will be able to emerge as a successful entrepreneur

PO8: COMMUNICATION SKILLS

Interact with engineering community and with society at large, regarding intricate engineering activities on technical perspectives and emerge as an efficient motivator. He will be able to communicate effectively both in verbal and non verbal forms.

PO9: INVESTIGATION OF COMPLEX PROBLEM

Perform investigations, design and conduct experiments, analyze and interpret the results to provide valid conclusion.

Mapping PEOs with POs									
POs/ PEOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
PEO1	✓	✓	✓	✓	✓		✓		✓
PEO2			✓	✓	✓	✓	✓	✓	✓
PEO3						✓	✓		
PEO4			✓	✓		✓		✓	

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MANUFACTURING ENGINEERING

Program: M.E **Specialization: Welding Engineering**

Courses of Study and Scheme of Examination (REGULATION-2019)

SEMESTER I									
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**
MFWEPC11	**PC-I**	Welding Processes - I	3	-		25	75	100	3
MFWEPC12	**PC-II**	Physical Metallurgy	3	-		25	75	100	3
MFWEPE13	**PE-I**	Program Elective - I	3	-		25	75	100	3
MFWEPE14	**PE-II**	Program Elective - II	3	-		25	75	100	3
MFWEMC15	**MC**	Research Methodology & IPR	2	-		25	75	100	2
MFWECP16	**CP-I**	Welding Processes Laboratory		-	3	40	60	100	2
MFWECP17	**CP-II**	Modelling & Simulation Laboratory	-	-	3	40	60	100	2
MFWEAC18	**AC-I**	Audit Course	2	-	-	-	-	-	0
		Total	Total			205	495	700	**18**

SEMESTER II									
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**
MFWEPC21	**PC-III**	Welding Processes - II	3	-	-	25	75	100	3
MFWEPC22	**PC-IV**	Welding Metallurgy	3	-	-	25	75	100	3
MFWEPE23	**PE-III**	Program Elective - III	3	-	-	25	75	100	3
MFWEPE24	**PE-IV**	Program Elective - IV	3	-	-	25	75	100	3
MFWEOE26	**OE-I**	Open Elective (Inter Faculty)	3	-	-	25	75	100	3
MFWECP25	**CP- III**	Weldability Testing & Evaluation Laboratory	-	-	3	40	60	100	2
MFWETS27	**TS**	Industrial Training and Seminar / Mini Project		2	2	40	60		2
MFWEAC28	**AC- II**	Audit Course							
			Total			205	495	700	**19**

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MANUFACTURING ENGINEERING

Program: M.E **Specialization: Welding Engineering**

Courses of Study and Scheme of Examination (REGULATION-2019)

SEMESTER III									
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**
MFWEPE31	**PE-V**	Program Elective - V	3	-	-	25	75	100	3
MFWEOE32	**OE-II**	Open Elective (Inter Faculty)	3	-	-	25	75	100	3
MFWEPV33	**TH-I**	Thesis Phase- I & Viva-voce	-	Pr 16	S 4	40	60	100	10
			Total			90	210	300	**16**

Note: * - Four weeks during the summer vacation at the end of II Semester.

SEMESTER IV									
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**
MFWEPV41	**TH-II**	Thesis Phase- II & Viva-voce	-	Pr 26	S 6	60	40	100	15
			Total			60	40	100	**15**

PC	Program Core	**CP**	Core Practical	**AC**	Audit Course
PE	Program Elective	**TS**	Industrial Training and Seminar	**PV**	Project work & Viva-voce
OE	Open Elective	**MC**	Mandatory Learning Course	**XX**	Branch code
				yy	M.E Specialization Code

DEPARTMENT OF MANUFACTURING ENGINEERING

M.E. (WELDING ENGINEERING) PART TIME - DEGREE PROGRAMME

Choice Based Credit System (CBCS)

Courses of Study and Scheme of Examination (REGULATION-2019)

S E M E S T E R – I										
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**	**Equivalent Course Code in M.E. Full Time**
PMFWEPC11	**PC-I**	Welding Processes - I	3	-	-	25	75	100	3	MFWEPC11
PMFWEPC12	**PC-II**	Physical Metallurgy	3	-	-	25	75	100	3	MFWEPC12
PMFWEMC13	**MC**	Research Methodology and IPR	2	-	-	25	75	100	2	MFWEMC15
PMFWECP14	**CP-I**	Welding Processes Laboratory	-	-	3	40	60	100	2	MFWECP16
Total						115	285	400	**10**	

S E M E S T E R – II										
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**	**Equivalent Course Code in M.E. Full Time**
PMFWEPC21	**PC-III**	Welding Processes - II	3	-	-	25	75	100	3	MFWEPC21
PMFWEPC22	**PC-IV**	Welding Metallurgy	3	-	-	25	75	100	3	MFWEPC22
PMFWEOE23	**OE-I**	Open Elective - I (Parent dept.)	2	-	-	25	75	100	3	MFWEOE26
PMFWECP24	**CP-III**	Modelling & Simulation Laboratory	-	-	3	40	60	100	2	MFWECP25
Total						115	285	400	**11**	

S E M E S T E R – III										
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**	**Equivalent Course Code in M.E. Full Time**
PMFWEPE31	**PE-I**	Program Elective-I	3	-	-	25	75	100	3	MFWEPE13
PMFWEPE32	**PE-II**	Program Elective-II	3	-	-	25	75	100	3	MFWEPE14
PMFWECP33	**CP-II**	Weldability Testing & Evaluation Laboratory	-	-	3	40	60	100	2	MFWECP17
Total						90	210	300	**8**	

DEPARTMENT OF MANUFACTURING ENGINEERING

M.E. (WELDING ENGINEERING) PART TIME - DEGREE PROGRAMME

Choice Based Credit System (CBCS)

Courses of Study and Scheme of Examination (REGULATION-2019)

S E M E S T E R – IV										
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**	**Equivalent Course Code in M.E. Full Time**
PMFWEPE41	**PE-III**	Program Elective-III	3	-	-	25	75	100	3	MFWEPE23
PMFWEPE42	**PE-IV**	Program Elective-IV	3	-	-	25	75	100	3	MFWEPE24
PMFWETS43	**TS**	Industrial Training and Seminar / Mini project		Tr	S	40	60	100	2	MFWETS27
				2	2					
Total						90	210	300	**8**	

S E M E S T E R – V										
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**	**Equivalent Course Code in M.E. Full Time**
PMFWEPE51	**PE-V**	Program Elective-V	3	-	-	25	75	100	3	MFWEPE31
PMFWEOE52	**OE-II**	Open Elective - II (Parent department.)	3	-	-	25	75	100	3	MFWEOE32
PMFWEPV53	**TH-I**	Thesis work & Viva-voce (Phase-I)		Pr	S	40	60	100	10	MFWEPV41
				16	4					
Total						**90**	**210**	**300**	**16**	

S E M E S T E R – VI										
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**	**Equivalent Course Code in M.E. Full Time**
PMFWEPV61	**TH-II**	Thesis work & Viva-voce (Phase-II)		Pr	S	40	60	100	15	MFWEPV33
				24	6					
Total						40	60	100	**15**	

P - Part-Time
XX – Department Branch Code
YY - PG Specialization
L: Lecture ,**P:** Practical,**T**: Thesis, **CA:** Continuous Assessment;**FE:** Final Examination

LIST OF PROFESSIONAL ELECTIVES

1. MFWEPEXX Design of Weldments
2. MFWEPEXX Testing & Inspection of Weldments
3. MFWEPEXX Welding Codes and Standards
4. MFWEPEXX Mechanical Behaviour of Materials
5. MFWEPEXX Applied Mathematics
6. MFWEPEXX Failure Analysis and Material Characterization
7. MFWEPEXX Non-Destructive Testing
8. MFWEPEXX Welding Automation
9. MFWEPEXX Advanced Materials Joining
10. MFWEPEXX Residual Stresses & Distortion
11. MFWEPEXX Welding Power Sources
12. MFWEPEXX Welding Application Technology
13. MFWEPEXX Repair Welding & Reclamation
14. MFWEPEXX Health, Safety & Environmental Aspects of Welding
15. MFWEPEXX Life Assessment of Welded Structures

LIST OF OPEN ELECTIVES

1. MFWEOEXX Corrosion Engineering
2. MFWEOEXX Additive Manufacturing
3. MFWEOEXX Surface Modification Techniques
4. MFWEOEXX Finite Element Analysis
5. MFWEOEXX Total Quality Management

LIST OF AUDIT COURSES

1. MFWEACXX English for Research Paper Writing
2. MFWEACXX Disaster Management
3. MFWEACXX Sanskrit for Technical Knowledge
4. MFWEACXX Value Education
5. MFWEACXX Constitution of India
6. MFWEACXX Pedagogy Studies
7. MFWEACXX Stress Management by Yoga
8. MFWEACXX Personality Development through Life Enlightenment Skills

FIRST SEMESTER

MFWEPC11	WELDING PROCESSES -I	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To impart a sound understanding of principles of different fusion welding processes.
- To understand the effect of welding parameters on weld quality.
- To study the importance of allied welding processes.

Introduction to Arc Welding: Classification of welding processes, arc physics, arc initiation methods; Electrical properties of arc – static arc characteristics – Power sources and power source characteristics – Modes of metal transfer; Manual metal arc welding**:** Ingredients and function of flux covering, different types of electrodes and their applications, handling and storage of consumables.

Gas tungsten arc welding (GTAW): Electrode polarity, shielding gas, use of DC suppression, arc starting and stopping, Modern developments: Pulsed GTAW, magnetic arc oscillation welding, hot wire GTAW, Activated GTAW, Plasma arc welding - Process characteristics, advantages and applications of above techniques.

Gas metal arc welding (GMAW): **C**onsiderations of electrode polarity, shielding gas and filler composition, CO_2 welding, flux cored arc welding; Variants of GMAW : Surface Tension Transfer (STT), Cold metal Transfer (CMT), Narrow groove GMAW welding - Process characteristics, advantages and applications of above techniques.

Submerged arc welding (SAW): Advantages and limitations, process variables and their effects, significance of flux-metal combination, modern developments; Electroslag welding and Electro gas welding: Principles, process variables, advantages, limitations and applications.

Allied Processes: Gas welding and cutting, flame characteristics, different kinds of flames and their areas of applications; Brazing: torch brazing and furnace brazing, wetting and spreading characteristics, Role of flux and characteristics constituents of flux, grouping and applications; Soldering: Hand soldering, flame soldering, furnace soldering, hot gas blanket soldering.

REFERENCES

1. Welding Handbook (Welding Processes), Volume II, 8th Edition, American Welding Society (AWS), 1991.
2. Metals Hand Book (Welding and Brazing), Volume VI, 9th Edition, American Society for Metals, 1989.
3. Little, R.L., Welding and Welding Technology, Tata McGraw Hill, New Delhi, 1996.
4. Nadkarni S.V., 'Modern Arc Welding Technology', Oxford and IBH Publisher, 1996
5. Parmar R. S., 'Welding Processes and Technology', Khanna Publishers, 2011.

COURSE OUTCOMES

Upon successful completion of the course, student should be able to:

1. Understand the principles of fusion welding processes.
2. Distinguish between consumable arc and non-consumable arc welding processes
3. Select an appropriate welding process for specific applications.
4. Acquire knowledge on modern developments in welding techniques
5. Awareness about allied welding processes.

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓	✓							
CO2		✓		✓			✓		✓
CO3			✓		✓	✓			
CO4	✓			✓				✓	
CO5	✓			✓					

MFWEPC12	**PHYSICAL METALLURGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To understand the different types of crystal structures.
- To study the phase changes in various alloys.
- To understand the various types of heat treatment techniques.

Unit cell, Crystal systems, BCC, FCC & HCP structures, Crystallographic planes & direction, Miller indices, Crystal imperfections - point, line & area defects. Constitution of alloys, compounds & solid solutions, Gibbs phase rule, lever rule – Phase diagrams, isomorphous, eutectic, peritectic, eutectoid and peritectoid reactions.

Diffusion in Solids, Fick's laws – Solidification, Nucleation and grain growth - constitutional supercooling, formation of dendrites - Directional solidification, Micro segregation, Macro segregation, Porosity and inclusions - Metallography - metallurgical microscope - preparation of specimen, micro & macro examination. Grain size ASTM grain size number, grain size measurement.

Iron- Carbon equilibrium diagram - Classification of steels - Purpose of alloying, effect of important alloying elements; Isothermal transformation diagram - Time Temperature Transformation Diagram, Continuous cooling transformation diagrams

Heat treatment of steel: full annealing, stress relief annealing, spheroidzing, normalizing, Hardenability and Jominy end quench test- Austempering and martempering - case hardening, carburising, nitriding, cyaniding, and carbon nitriding, flame hardening, induction hardening, vacuum hardening and cryogenic treatment.

Strengthening Mechanisms: Solid solution strengthening, Grain boundary strengthening, Cold working, Strain Aging, Strain hardening, Fine particle strengthening, Fibre strengthenning, Martensitic Strengthening - Grain refinement, Hall-Petch relation**.**

REFERENCES

1. Sydney, H., Avner, S.H., "Introduction to Physical Metallurgy", McGraw Hill, 2008.
2. Raghavan, V., "Materials Science & Engineering", Prentice Hall of India Pvt.Ltd, 2015.
3. Higgins, R.A., "Engineering Metallurgy - Part I, Applied Physical Metallurgy", ELBS., 1993.
4. Williams, D., "Material Science and Engineering", Callister Wiley India Pvt. Ltd, Revised Indian edition, 2007.
5. George E. Dieter., "Mechanical Metallurgy", McGraw Hill Book Company, New York, 1988.

COURSE OUTCOMES

Upon successful completion of the course, student should be able to:

1. Understand the basics of crystal structure.
2. Acquire knowledge on phase diagrams.
3. Select the heat treatment methods for specific alloys.
4. Design the alloys for specific applications.
5. Develop mechanisms to strengthen metals and alloys.

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓	✓	✓		✓				
CO2				✓				✓	
CO3		✓	✓						
CO4	✓			✓			✓		
CO5			✓		✓				✓

MFWEMC15	RESEARCH METHODOLOGY AND IPR	L	T	P	C
		2	0	0	2

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

Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Nature of Intellectual Property: 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.

Patent Rights: 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.

REFERENCES

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

COURSE OUTCOMES

At the end of this course, students will be able to

1. Understand research problem formulation.
2. Analyze research related information
3. Follow research ethics
4. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about
6. Intellectual Property Right to be promoted among students in general & engineering in particular.
7. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1		✓					✓		
CO2	✓		✓	✓		✓		✓	✓
CO3	✓	✓							
CO4					✓				✓
CO5	✓		✓					✓	

MFWECP16	**WELDING PROCESSES LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**2**

COURSE OBJECTIVES

- To understand the various joint configuration in welding.
- To study the effect of welding parameters on joint characteristics.
- To get hands on experience on software packages related to welding.

LIST OF EXPERIMENTS

1. Simple exercises to make butt, lap, fillet joints using SMAW, GMAW, FCAW and GTAW processes.

2. Studying the effect of electrode polarity on weld bead formation
3. Studying the effect of heat input on temperature distribution
4. Evaluating the performance of Power Source Characteristics
5. Studying the effect of shielding gases on weld quality
6. Studying the effect of welding parameters of various processes such as SMAW, GMAW, FCAW, GTAW on bead geometry
7. Studying the effect of friction welding parameters on weld quality
8. Studying the effect of friction stir welding parameters on weld quality
9. Studying the effect of electrical resistance welding parameters on weld nugget formation

COURSE OUTCOMES

Upon successful completion of the course, student should be able to:

1. Acquire practical knowledge on fusion and solid state welding processes.
2. Understand the effect of welding parameters on quality of welded joint.
3. Expertise on using welding software packages.
4. Analyse the experimental results using statistical tools
5. Evaluate various input parameters and their effects

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO5**	**PO5**	**PO5**	**PO5**
CO1	✓	✓			✓				✓
CO2		✓	✓			✓		✓	
CO3	✓		✓	✓	✓				
CO4				✓		✓	✓		✓

MFWECP17	**MODELLING & SIMULATION LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**2**

COURSE OBJECTIVES

- To introduce the students to the field of Programming and usage of Software Packages related to Welding such as SYSWELD, COMSOL etc.,
- To enhance the analyzing and problem solving skill of the students.
- To deal with the practical aspects of the Core and Elective subjects offered in the programme.
- To impart the practical insight of these subjects to the students through the actual implementation analysis and/or simulation.

LIST OF EXPERIMENTS

1. Predicting the temperature distribution during fusion welding process by SYSWELD software
2. Predicting the residual stress distribution during fusion welding process by COMSOL software
3. Modeling of Gas Tungsten Arc Welded Butt Joint using SYSWELD Software
4. Modeling of Laser Welded Butt Joint using SYSWELD Software
5. Thermal Analysis of Friction Stir Welding Process using COMSOL multiphysics Software

COURSE OUTCOMES

Upon successful completion of the course, student should be able to:

1. Know concepts in problem solving
2. Analyze simulation results
3. Prepare effective documentation
4. Acquire expertise in usage of modern software

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓				✓				
CO2		✓							
CO3	✓								✓
CO4					✓				

SECOND SEMESTER

MFWEPC21	**WELDING PROCESSES - II**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To acquire fundamental knowledge on principles of solid state welding processes.
- To understand the effect of welding parameters on weld quality.
- To study the importance of advanced welding processes.

Electrical Resistance Welding: General principle- heat generation in resistance welding- Electrical Characteristics of Resistance welding; Thermal Characteristics of Resistance Welding Heat Balance; Spot welding: Principle, welding sequence- Solidification in Resistance Spot Welding-applications of spot welding. Projection welding and Seam welding - Process details and working principle – parameters and their effects on weld quality - applications.

Friction based processes: Introduction, working principle, difference between friction welding and inertia welding, Operation steps, Metallurgy of friction welded joints, Fibre flow in friction welding, Defect formation, Process parameters, Applications; Friction Stir Welding: Introduction-working principle, Operation steps, Metallurgy of FSW joints, Defect formation-Process parameters, Tool design, tool geometry and tool materials, Heat generation in FSW process, Variants of FSW process;

Ultrasonic welding: Principle of operation, Metallurgy of ultrasonic welds, welding equipment, welding variables, types of ultrasonic welds, materials ultrasonically welded, advantages, disadvantages and applications of ultrasonic welding. Diffusion welding: Principle, types, parameters, materials welded, advantages, limitations and applications of diffusion welding. Explosive welding: principle, mechanism, arrangements, explosives used, metallurgy of explosive welds, testing of explosive welded joints, advantages, limitations and applications of explosive welding.

Beam Welding Processes: Basics of Laser, types of Lasers, Gaseous systems: - CO_2 Laser welding; Solid state Laser welding; Laser beam characteristics – Continuous Wave lasers, Pulsed Laser, High power diode lasers (HPDL) and Fibre Lasers; Principles of operation, effect of parameters on weld quality, advantages, and limitations, applications. Electron beam welding: Fundamentals; Beam characteristics; Different degrees of vacuum, Heat generation and regulation, equipment details in typical set-up, Parameters and its effects on weld quality, advantages and disadvantages, applications, characteristics of electron beam welded joints.

Allied Processes: Principle and concept of narrow gap welding, under water welding, thermit welding. Process characteristics, advantages and applications of above techniques. Principles and concepts of Induction brazing, Dip brazing, Resistance brazing, Vacuum brazing; Adhesive Bonding; High Frequency Welding; MIAB welding; Microwave joining.

REFERENCES

1. Hongyan Zhang and Jacek Senkara, Resistance welding: Fundamentals and Applications, Second Edition, CRC Press, 2011.
2. John Norrish. "Advanced welding processes Technologies and process control" Wood head Publishing and Maney Publishing. Cambridge, England. 2006.
3. Christopher Davis. "Laser Welding- Practical Guide". Jaico Publishing House. 1994.
4. Rajiv S. Mishra, Murray W. Mahoney, Friction Stir Welding and Processing, ASM International, 2007.

COURSE OUTCOMES

Upon successful completion of the course, student should be able to:

1. Understand the variants of resistance welding processes.
2. Acquire knowledge on friction based processes.
3. Utilize advanced joining techniques for critical applications
4. Select an appropriate welding process for a specific application.
5. Gain knowledge of allied welding processes

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓		✓						✓
CO2		✓		✓		✓			
CO3	✓		✓		✓			✓	
CO4	✓		✓		✓		✓		✓

MFWEPC22	**WELDING METALLURGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To understand the different types of zones formed during welding.
- To study the weldability of carbon and stainless steels.
- To understand the weldability of non-ferrous alloys.

Heat flow in welding: temperature distribution in welding, heat flow equations, simple problems, metallurgical effects of heat flow in welding. Regions of a Fusion Weld, Fusion Zone, Solidification of Metals, Macroscopic Aspects of Weld Solidification, Microscopic Aspects of Weld Solidification, Unmixed Zone (UMZ), Partially Melted Zone (PMZ),

Penetration Mechanism, Segregation Mechanism, Heat Affected Zone (HAZ), Recrystallization and Grain Growth.

Weldability of Carbon Steels: Significance of carbon equivalent number, important problems encountered in welding of HSLA steels, Q&T steels, Cr-Mo steels and remedial steps; Preheat and Post heat requirements. Austenite-to-Ferrite transformation in low-carbon, low-alloy steel welds, Microstructure development, Factors affecting microstructure.

Weldability of Stainless Steels: stainless steel classification, Schaffler diagram, Delong diagram, WRC diagrams, problems associated with welding of austenitic stainless steel, ferritic stainless steel, martensitic stainless steel and duplex stainless steels;

Classification of aluminium alloys – various processes used for aluminium welding- problems involved in aluminium welding – precaution and welding procedure requirements- CCT diagrams of aluminium alloys, Age hardening behaviour of aluminium welds. Classification of magnesium alloys – various processes used for magnesium welding- problems involved in magnesium welding – precaution and welding procedure requirements.

Classification of titanium alloys – various processes used for titanium welding- problems involved in titanium welding – precaution and welding procedure requirements; Classification of nickel alloys – various processes used for nickel welding- problems involved in nickel welding – precaution and welding procedure requirements; CCT diagrams of Ti and Ni base alloys. Microstructural features of Ti and Ni base alloy welds.

REFERENCES

1. Sindo Kou, Welding metallurgy, 2nd edition, John Wiley & Sons, 2003
2. John C. Lippold, Damian J. Kotecki, Welding metallurgy and weldability of stainless steels, 2005.
3. Saferian.D, The Metallurgy of Welding, Pergamon Press, 1985.
4. Linnert G.E, Welding Metallurgy, Vol I & II, 4th edition, American Welding Society, 1994.
5. Kenneth Easterling, Introduction of Physical Metallurgy of Welding, 2nd Edition, Butterworth - Heinman, 1992.
6. Welding Engineering and Technology, R.S. Parmar, Khanna Publishers, 2013.

COURSE OUTCOMES

Upon successful completion of the course, student should be able to:

1. Understand the interaction between heat and metals/alloys.
2. Predict the microstructure of different regions of a weldment.
3. Understand the weldability issues in ferrous and non-ferrous alloys.
4. Estimate the pre-heat, post heat and interpass temperatures for welding.
5. Select appropriate welding procedures to weld a specific alloy.

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓		✓	✓				✓	
CO2		✓							
CO3	✓		✓		✓	✓	✓		✓
CO4		✓		✓					
CO5	✓				✓	✓		✓	✓

MFWECP26	WELDABILITY TESTING & EVALUATION LABORATORY	L	T	P	C
		0	0	3	2

COURSE OBJECTIVES

- To evaluate the mechanical properties of welded joints.
- To gain practical knowledge on hot and cold crack tests.
- To provide training on NDT instruments.

LIST OF EXPERIMENTS

1. Tensile properties evaluation of welded joints
2. Impact toughness properties evaluation of welded joints
3. Microhardness survey across the weld cross section
4. Bend Test (side and face) on welded joints
5. All weld metal properties evaluation
6. Macro and Micro structure analysis of weldments
7. Implant Testing for Hydrogen Induced cracking
8. Controlled Thermal Severity Test
9. Flaw Detection by Ultrasonic Testing
10. Flaw Detection by Magnetic Particle Inspection
11. Flaw Detection by Eddy Current Testing
12. Study of RT Films

COURSE OUTCOMES

Evaluate the mechanical properties of welded joints as per standards.

1. Characterize microstructural features using modern tools.
2. Acquire practical knowledge on weldability testing.
3. Inspect weld quality as per the standards.
4. Utilize NDT instruments to assess the damages in welded joints.

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓		✓			✓			
CO2		✓			✓			✓	
CO3		✓	✓			✓			✓
CO4				✓	✓		✓		

MFWETS27	INDUSTRIAL TRAINING AND SEMINAR / MINI PROJECT	L	T	P	C
		0	2	2	2

COURSE OBJECTIVES

- To train the students in the field work related the Welding Engineering and to have a practical knowledge in carrying out welding field related works.
- To train and develop skills in solving problems during execution of certain works related to Welding Engineering.
- To work on a technical topic related to Welding Engineering and acquire the ability of written and oral presentation
- To acquire the ability of writing technical papers for Conferences and Journals

INDUSTRIAL TRAINING:

The students individually undergo a training program in reputed concerns in the field of Welding Engineering during the summer vacation (at the end of second semester for full – time / fourth semester for part – time) for a minimum stipulated period of four weeks. At the end of the training, the student has to submit a detailed report on the training he had, within ten days from the commencement of the third semester for Full-time / fifth semester for part-time. The students will be evaluated by a team of staff members nominated by head of the department through a viva-voce examination.

** - Four weeks during the summer vacation at the end of II Semester.*

SEMINAR:

The students will work for two periods per week guided by student counsellor. They will be asked to present a seminar of not less than fifteen minutes and not more than thirty minutes on any technical topic of student's choice related to Welding Engineering and to engage in discussion with audience. They will defend their presentation. A brief copy of their presentation also should be submitted. Evaluation will be done by the student counselor based on the technical presentation and the report and also on the interaction shown during the seminar.

COURSE OUTCOMES

1. Expose the students in the actual industrial environment
2. Understand the difference between theory and practice
3. Verify the theory with practical work
4. The students will be getting the training to face the audience and to interact with the audience with confidence.
5. To tackle any problem during group discussion in the corporate interviews.

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓	✓			✓		✓		✓
CO2		✓	✓	✓		✓			
CO3	✓		✓		✓			✓	
CO4		✓		✓	✓		✓		✓
CO5	✓		✓			✓			

THIRD SEMESTER

		L	T	P	C
MFWETH33	**THESIS PHASE-I & VIVA-VOCE**	**0**	**16**	**4**	**10**

COURSE OBJECTIVES

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students in preparing project reports and to face reviews and viva voce examination.

COURSE OUTCOMES

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

1. Take up any challenging practical problems and find solution
2. Learn to adopt systematic and step-by-step problem solving methodology

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓	✓			✓		✓		✓
CO2		✓	✓	✓		✓		✓	

FOUURTH SEMESTER

MFWETH41	**THESIS PHASE-II & VIVA-VOCE**	**L**	**T**	**P**	**C**
		0	**24**	**6**	**15**

COURSE OBJECTIVES

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students in preparing project reports and to face reviews and viva voce examination.

COURSE OUTCOMES

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

1. Select the application oriented industry problem.
2. Capable to solve the problems by applying scientific methods
3. Prepare technical reports and research paper

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓		✓		✓				✓
CO2		✓		✓			✓		
CO3	✓		✓		✓			✓	

PROFESSIONAL ELECTIVE COURSES

MEWEPEXX	**DESIGN OF WELDMENTS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To understand the basics of engineering mechanics.
- To understand the different types of joints and its effects.
- To study the life assessment and fracture mechanics concepts.

Introduction to Engineering Mechanics: Free body diagram- types of supports and their reactions, Requirements of stable equilibrium, Moment of a Couple, Moments of force about a point and an axis, Vectorial representation of moments and couples, Scalar component of a moment, Equilibrium of rigid bodies in Two and Three Dimensions, Free body diagram and equilibrium of trusses and frames.

Properties of Solids: Determination of Areas, first moment of area, Centroid of sections- Rectangle, circle, triangle, T-Section, I-Section, Angle section and Hollow section, Second and product moments of plane area – Rectangle, circle, triangle, T-Section, I-Section, Angle section and Hollow section, Parallel axis theorem, Perpendicular axis theorem, Polar moment of inertia, Mass moment of inertia- Thin plates and simple solids.

Types of weld joints, butt joint, lap joint, T-joint, cruciform joint, corner joint and edge joint, fillet and groove welds. complete and partial joint penetration, classification and types of groove welds, single and double fillet welds, combined partial joint penetration groove and fillet welds, size of fillet and groove welds, weld symbols, standard system of representation of welded joints, brazed and soldered joints.

Design of Welded Joints, Joint design based on stresses in the structure; Joint design for structural elements such as bars, beams, plates, slabs, columns, trusses, plate girders, cylindrical shells and pressure vessels and pipe lines. Design for flanged connections, structural hollow sections and branch connections; Welded joint design to control distortion and shrinkage, residual stresses and cracking.

Weld design for dynamic loading: Design for fluctuating and impact loading - dynamic behaviour of joints - stress concentrations - fatigue analysis - fatigue improvement techniques - permissible stress- life prediction. Principles and methods and practical approach for crack arresting; Concept of stress intensity factor - LEFM and EPFM concepts - brittle fracture-transition temperature approach - fracture toughness testing, application of fracture mechanics to fatigue, weldments design for high temperature applications.

REFERENCES

1. Engineering Mechanics (Statics and Dynamics) by Mclean and Nelson (Schaum's Outline Series) McGraw-Hill Book Company
2. Engineering Mechanics by Irving H. Shames, Prentice-Hall of India, 4th ed., 2004.
3. Gray T. G. E. "Rational Welding Design", Butterworth's, 1982.
4. Bhattacharya M. "Weldment Design", Association of Engineers, 1991.
5. Radhakrishnan V. M. "Welding Technology and Design", Revised Second Ed., New Age International Publishers. 1998.
6. Hertzberg R. W. "Deformation and Fracture of Mechanics of Engineering Materials", John Wiley, 1996.
7. Dieter G. "Mechanical Metallurgy", Tata McGraw Hill, 1988.

COURSE OUTCOMES

Upon successful completion of the course, student should be able to:

1. Acquire knowledge on mechanics of solids.
2. Understand the different configurations of the welds.
3. Estimate stresses acting on welded joints.
4. Apply fracture mechanics concepts to design the welds
5. Design a welded assembly for a specific application.

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓	✓			✓	✓			
CO2		✓		✓				✓	
CO3	✓		✓						✓
CO4			✓	✓		✓	✓		
CO5		✓			✓				✓

MEWEPEXX	**TESTING AND INSPECTION OF WELDMENTS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To understand the various weld defects and cracks.
- To impart a sound understanding of various weldability test.
- To study the basics of non-destructive test.

Weld defects and cracks: arc welding defects, classifications of cracks - hot and cold cracks, orientation of weld cracks- weld metal crack, base metal crack- factor contributing, specific crack- cheveron, lamellar, reheat crack; Fabrication Weldability Test: Houldcroft Tests - Lehigh Restraint Test - Variable-Restraint (or Varestraint) Test - Murex Hot-Cracking Test - Root-Pass Crack Test.

Hydrogen Induced Cracking (HIC) Testing**:** Implant Test - RPI Augmented Strain Cracking Test - Controlled-Thermal-Severity (CTS) Test - Lehigh Slot Weldability Test - Wedge Test- Tekken Test - Gapped-Bead-on-Plate or G-BOP Test; Service Weldability Test: Tensile test, nick break test, bend test, impact test.

Corrosion Tests: General Corrosion and its testing - Pitting Corrosion and its Testing - Intergranular Corrosion and its testing - Stress Corrosion and its Testing; Standards, testing procedures, and importance of the above tests.

Liquid Penetrant Testing - Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetisation methods, Interpretation and evaluation of test indications; Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Radiography Testing: Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, characteristics of films - graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence.

REFERENCES

1. Nadkarni. S. V. “Modern Arc Welding Technology”, Oxford IBH. 1996.

2. R.S.Parmar, Welding Engineering & Technology, Khanna Publishers, New Delhi, 2013.
3. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2009.
4. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010.

COURSE OUTCOMES

Upon successful completion of the course, student should be able to:

1. Understand the causes of various welding defects and prevention methods.
2. Acquire knowledge on weldability testing and procedures.
3. Select an appropriate weldability test for a specific application.
4. Design weldments against environmental damage.
5. Distinguish between destructive and non-destructive testing.

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓	✓	✓		✓	✓			✓
CO2	✓	✓							
CO3		✓	✓		✓		✓	✓	
CO4	✓		✓	✓					✓
CO5			✓		✓	✓		✓	

MEWEPEXX	**WELDING CODES AND STANDARDS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To study the welding procedure specifications and procedure qualification records.
- To study the codes and standards related to welding and its testing.
- To improve the quality of welded components.

Welding Procedure Specification (WPS); Procedure Qualification Record (PQR); Essential Variables; supplementary essential and non-essential variables; Base Material Grouping: P numbers and Group numbers. Filler Metal Grouping: F number and A numbers. Introduction to ASME sec IX: Article I to IV.

Welding procedure qualification preparation of preliminary WPS; test plan: Preparation of test coupon/ welding of a test coupon welding parameter record; Post weld heat treatment and NDE; Marking, Machining and testing, evaluation of test result; Preparation of Procedure Qualification Record (PQR); Re-Write the WPS based on welding Parameter record and ASME Qualification range;

NACE MR0175 requirements - hardness test requirement and acceptance criteria; Additional requirement for API 6A, API 16A, API17D; Determination of pre heating and post weld heat treatment requirement based on ASME VIII.

Welding consumable testing as per ASME sec II C- All weld test (Tensile & Impact); Brief Introduction to AWS D1.1, API 1104, ISO – Procedure qualification and welder qualification requirements. Quality control: Welding Quality requirements, Quality Assurance, Quality Plan, Quality Standards for Welding;

Welder's Qualification based on ASME IX requirements; Selection and welding of a test coupon for welder qualification; qualification based on RT and bend test; qualification range; Continuity record; requalification Qualification based on first productive weld; Welder qualification based on IBR requirements. Welder Testing on different position of welding, Brief introduction and awareness on certification for welding inspector AWS, CWSIP, International Welding Engineers.

REFERENCES

1. AWS D1.1 Structural Welding Code, 2011.
2. API 5L, 2009
3. API 1104, 2008
4. ASME Section VIII – Division 1, 2011.
5. ASME Section IX, 2011.
6. ASME Section II Part A and C, 2011.

COURSE OUTCOMES

Acquire knowledge on welding procedures.

1. Prepare the procedure qualification record.
2. Select a consumable for a specific application.
3. Assure the quality of welded joints.
4. Understand the national and international codes and standards.
5. Select appropriate tests for welder qualification

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓	✓			✓				✓
CO2		✓		✓					
CO3	✓		✓				✓		
CO4			✓	✓	✓	✓			
CO5	✓		✓			✓			✓

MEWEPEXX	**MECHANICAL BEHAVIOUR OF MATERIALS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To impart a sound understanding of the tensile, hardness and toughness behaviour of materials.
- To understand the factors affecting the fatigue and fracture behaviour of materials.
- To study the time dependant mechanical behaviour of materials.

Tensile behaviour: Engineering stress-strain curve: Derivation of tensile strength, yield strength, ductility, modulus of elasticity, resilience and toughness from stress strain curves, comparison of stress-strain curves for different materials - True Stress - Strain Curve: true

stress at maximum load, true fracture strain, true uniform strain, Necking strain - necking Criteria - Effect of strain rate, temperature and testing machine on flow properties - Notch tensile test - Tensile properties of steel - strengthening mechanisms - Strain hardening - Strain aging - Yield point phenomena - Solid solution strengthening - Martensite Strengthening - Grain refinement, Hall-Petch relation.

Hardness & Toughness behaviour: Hardness Measurements: Brinnell hardness, Meyer's hardness, Vickers hardness, Rockwell hardness and Microhardness - Relationship between hardness and the flow curve - Hardness at elevated temperatures - Toughness measurements: Charpy, Izod and Instrumented Charpy - Transition Temprature Curves: significance, various criteria, metallurgical factors affecting the curves, Drop weight test, explosion crack starter test, Dynamic tear test and Robertson crack arrest test - Fracture Analysis Diagram.

Fatigue behaviour: Introduction: Stress cycles, S-N curves Goodman diagram, Soderberg diagram, Gerbar diagram - Cyclics stress strain curve - Low cyle fatigue - Strain life Equation - Fatigue mechanisms - High cycle fatigue - Effect of following paramenters on Fatigue: mean stress, stress concentration, specimen size, surface roughness, residual stress, microstructure and temperature. Fatigue crack propagation - Fatigue under combined stresses - Cumulative fatigue damage - Design for fatigue.

Fracture behaviour: Types of fracture in metals: ductile and brittle fracture - Theoretical cohesive strength of metals - Griffith theory - Metallographic aspects of fracture - Fractography - Notch effect - Concept of fracture curve - Fracture under Combined Stresses - Environment sensitive fracture: hydrogen embrittlement, stress corrosion cracking - Fracture mechanics: strain energy release rate, stress intensity factor, crack deformation modes, fracture toughness testing, plastic zone size correction, crack opening displacement, J-integral and R-curve.

Time dependant mechanical behaviour: Creep curve - Stress rupture Test - Structural changes during creep - Mechanisms of creep deformation - Deformation mechanisms maps - Activation energy for steady state creep - Fracture at elevated temperature - Introduction to high temperature alloys - Predication of long time properties - Creep under combined stresses - Creep- Fatigue Interaction.

REFERENCES

1. George E.Dieter, Mechanical Metallurgy, Tata McGraw – Hill Education Pvt.Ltd, 3rd Edition. New Delhi, 2014.
2. Hertzberg R.W., Richard W. Hertzberg , Richard P. Vinci , Jason L. Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, John Wiley & Sons, Inc., 5th Revised Edition, New York, 2012.
3. Thomas Courtney. H, Mechanical Behavoiur of Materials, McGraw Hill 2nd Edition, 2005.
4. M.A.Meyers and K K.Chawla, Mechanical Behavior of Materials, Cambridge University Press, 2009
5. H. Kuhn and D. Medlin , Metals Handbook, Mechanical Testing, Vol.8, American Society for Metals, Metals Park, Ohio, 2000
6. Broek.D, Elementary Engineering Fracture Mechanics, 4th Edition.,Martinus Nijhoff Publishing , The Hague, 2008

COURSE OUTCOMES

Upon successful completion of the course, student should be able to:

1. Understand the mechanical behaviour of metals;
2. Protect the metals from fatigue damage.
3. Understand the environmental factors affecting the mechanical behaviour of materials
4. Evaluate the high temperature properties of metals.
5. Design the metals for specific applications

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓	✓			✓				✓
CO2		✓	✓			✓		✓	
CO3			✓	✓					
CO4				✓			✓		
CO5	✓	✓			✓				✓

MEWEPEXX	**APPLIED MATHEMATICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To acquaint the student with the concepts in ordinary differential equations and vector calculus.
- To introduce probability theory and statistics from a computational perspective
- To enable the students to use the concepts of Testing of hypothesis, regression, correlation & Design of experiments

Two dimensional heat flow in transient state both in rectangular and circular plate - Three dimensional heat flow in transient state – Laplace equations in Cartesian, cylindrical and spherical polar coordinate systems; Solution of boundary value problems in ordinary differential equation – Introduction – Method of Finite Differences – Boundary conditions which do not involve dy/dx – Boundary conditions which involve dy/dx.

Maxima and Minima of functions of two variables – Lagrange multipliers – Functionals – Strong and Weak variations- Variational notation – Euler Lagrange equation –Euler Lagrangian equations for functional with higher order derivatives – simultaneous Euler Lagrangian equations for functionals with several independent variables subject to constraints.

Introduction to probability theory – Random variable – Probability density and distribution functions – Standard distributions: Geometric, Hypergeometric, Binomial, Poisson, Normal, Log-Normal, Exponential, Gamma, Beta and Weibull distributions – Applications – Baye's Theorem – Chebysev's Theorem.

Sampling distributions of statistical parameters – Standard error – central limit theorem – t, F and Chi-square distributions - Estimation – Point estimation - Interval estimation for population means, standard deviation, proportion, difference in mean, ratio of standard deviations, proportions - Maximum likelihood estimation, least square estimation and bayesian estimation.

Experimental designs – completely randomised blocks– Latin square – Analysis of variance – Methods for one, two factor models, concepts of factorial design, fractional factorial design, response surface methods and designs.

REFERENCES

1. M.K.Venkatraman, Higher Engineering Mathematics for Engineers, National Publishing Company, 1994.
2. M.R. Spiegel, Advanced Mathematics for Engineering Scientists, Mc Graw Hill, 1985.
3. Irwin Miller & John Freund, Probability and Statistics for Engineers, , Prentice Hall of India, 2001.
4. D.C.Montgomery and G.C.Runger, Applied Statistics and Probability for Engineers, John Wiley and Sons, USA, 1994.

COURSE OUTCOMES

Upon successful completion of the course, student should be able to:

1. Understand the basic concepts of differential equations and complex variables.
2. Solve the real life problems and Engineering problems.
3. Acquire basic knowledge in probability and statistics
4. Know the basic merits and demerits of various statistical tools
5. Plan the experiments and analyse the data scientifically.

Mapping of COs with POs									
COS/POS	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓		✓		✓	✓			✓
CO2		✓	✓		✓		✓		
CO3	✓		✓	✓					
CO4		✓		✓		✓		✓	✓
CO5	✓			✓	✓		✓		

MEWEPEXX	**FAILURE ANALYSIS & MATERIALS CHARACTERIZATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To understand different types of failures and its prevention.
- To understand the working principles of optical and electron microscopy.
- To study about the X-ray diffraction techniques.

Types of failure, causes and classification of failures, Classification and identification of various types of fractures. Stages of failure analysis: Site visit, Collect background information, Sample removal and testing protocol, Sample removal, Cleaning, and storage, Chemical analysis, Testing.

Fracture characteristics revealed by microscopy, characteristics of ductile and brittle fracture, factors affecting fatigue failures, creep failures, creep-fatigue failures, corrosion-fatigue failures, stress corrosion failures; Failure of weldments - reasons for failures, procedures for weld failure analysis; Some case studies of weld failures in aerospace, shipbuilding,

petroleum industries, oil & gas, food processing, paper & pulp, pressure vessels & piping, power plants, etc.

Optical Metallography - Macro examination, principle and working of optical microscope, specimen preparation, optical properties - numerical aperture, resolving power, depth of focus, depth of field, aberrations in optical microscopes and their remedial measures, different microscopic techniques-dark field microscopy, phase-contrast microscopy, polarized light microscopy, interference microscopy, high temperature microscopy; quantitative metallography.

Techniques of Electron Microscopy - Transmission electron microscope - specimen preparation, imaging modes, applications, selected area diffraction; Scanning electron microscope - operating modes and applications, electron probe micro analyser - qualitative and quantitative analysis, Atomic force microscopy, field ion microscopy - principle, instrumentation and applications.

X Ray Diffraction Techniques: Bragg's law – Diffraction methods – Laue, rotating crystal and powder methods. Intensity of diffracted beams – structure factor calculations. Diffractometer – general feature and optics – proportional scintillating and Geiger counters. X-ray diffraction application in the determination of crystal structure, lattice parameter and residual stress – quantitative phase estimation. Surface Chemical Analysis Techniques: - Auger Electron Spectroscopy–principle, instrumentation and applications in metallurgy.

REFERENCES

1. Metals Hand Book, Failure Analysis and Prevention, Vol. 11, ASM, 2002.
2. Rolfe and Barsom, Fracture and Fatigue control in structures, Prentice Hall, 1992.
3. Angelo P C, "Materials Characterization", Reed Elsevier India Pvt Ltd, 2013.
4. Whan R E (Ed), ASM Handbook, Volume 10, Materials Characterisation ", ASM international, USA, 1986.
5. Phillips V A, "Modern Metallographic Techniques and their Applications", Wiley Eastern, 2001.
6. Cullity B D., Stock S R "Elements of X-ray Diffraction", Prentice Hall, Inc 2001.

COURSE OUTCOMES

Upon successful completion of the course, student should be able to:

1. Differentiate different types of failures in metals.
2. Identify the causes for various failures.
3. Acquire knowledge on characterization tools.
4. Understand the environmental factors promoting the failures.
5. Select an appropriate tool to analyse a specific failure.

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓	✓			✓	✓			✓
CO2		✓	✓					✓	
CO3	✓		✓				✓	✓	
CO4				✓	✓				
CO5	✓	✓		✓	✓	✓			✓

MEWEPEXX	NON-DESTRUCTIVE TESTING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To understand the difference between destructive and non-destructive testing.
- To study the various non-destructive testing methods.
- To understand the application non-destructive testing in welding.

Non Destructive Testing Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT., Visual inspection – Unaided and aided.

Liquid Penetrant Testing - Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetisation methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

Thermography- Principles, Contact and non contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation - infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique –Principle, AE parameters, Applications.

Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films - graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography

REFERENCES

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu Practical Non-Destructive Testing, Narosa Publishing House, 2009.
2. Ravi Prakash, Non-Destructive Testing Techniques, 1st revised edition, New Age International Publishers, 2010.
3. ASM Metals Handbook, Non-Destructive Evaluation and Quality Control, American Society of Metals, Metals Park, Ohio, USA, Volume-17, 2007.
4. Paul E Mix, Introduction to Non-destructive testing: a training guide, Wiley, 2 Edition New Jersey, 2005.

COURSE OUTCOMES

Upon successful completion of the course, student should be able to:

1. Understand the principle of non-destructive testing methods

2. Acquire knowledge on limitations and merits of each technique
3. Determine the location of sub surface cracks
4. Use of modern tools to assess the weld quality
5. Select a suitable non-destructive test method for a specific application

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓		✓		✓		✓		✓
CO2		✓		✓				✓	
CO3	✓		✓			✓		✓	
CO4		✓		✓					✓
CO5					✓	✓	✓		

MEWEPEXX	**WELDING AUTOMATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To impart a sound understanding of automated devices used for welded structures.
- To study the importance of computer integrated manufacturing.
- To acquire knowledge on design and control of robots in welding.

Automated devices for welded structures- Pre assembly and tacking by welding distortion by welding and its prevention tolerances welded structure and the concept of automated devices complexity of devices for pre assembly and mechanization/automation in welding. Mechanisation of pipes and tubes - Butt welding, TIG orbital welding of thin and thick Members; MIG/MAG orbital welding induction pressure welding, flash butt welding tube-tube-plate welding

Mechanisation in welding: Mechanisation of flat / circular joints thin / thick sheets (Resistance weld/arc weld) mechanization of I beams (arc welding) longitudinal circumferential submerge arc welding (roller blocks, column booms, flux supports) circular / spherical welding joints (rotating tables positioners) manufacture of welding longitudinal welded pipes by induction, TIG, plasma and SA welding a spiral welded pipes.

Concept of automation lines - The tolerances and welding procedures and quality, auxillary equipment (fixture, transport, electrical, pneumatic, hydraulic) welding procedures for automation. Automatic lines for welding, automation of track wheels, automation of pipe's spiral welding.

Introduction to CIM: An overview of CIM – Significance of CIM; Flexible Manufacturing System (FMS): Definition – Components – Types – Flexibilities – Materials Handling and storage system: Conveyors: Types – Automated Guided Vehicle (AGV): Types, Guidance and Routing – Automated Material Handling and Storage system (AS/RS) – FMS Layouts – Benefits of FMS; Group Technology (GT): Part family – Parts classification and coding – Cellular Manufacturing – Benefits of GT.

Industrial Robotics: Automation and Robotics – Robot Anatomy, Joint motions – End effectors: Grippers and Tools – Robotic sensors – Robot vision system – Robot programming

– Robot cell: Types – Design and control; Robotics in welding - The concept of robotics, the robot design and its applications for welding, welding procedures adequate for robotics, programming of robot's welding tolerances of assemblies for robot welding, auxillary devices for robot welding, new generation of welding robots, self-alignment by current arc variation, light spot leading system.

REFERENCES

1. The Procedure Handbook for Arc Welding", Lincoln Electric. USA, 2012.
2. Welding Handbook, Vol. 3, 7th edn., American Welding Society, 1998.
3. Kozyrev, "Industrial Robots Handbook", Mir Publishers, Moscow, 2011.
4. M.P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Prentice-Hall of India Pvt. Ltd., New Delhi, 2002.
5. M.P. Groover, Mitchell Weiss, Roger N. Nagel and Nicolas G. Odery, Industrial Robotics: Technology, Programming and Applications, McGraw-Hill Book Co., 1986.

COURSE OUTCOMES

Upon successful completion of the course, student should be able to:

1. Understand the working principles of automated devices.
2. Improve the welding performance through automation.
3. Apply the robots in critical components welding.
4. Design an automation layout for specific component fabrication.
5. Integrate computers, robots and welding processes.

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓	✓		✓		✓		✓	
CO2		✓			✓				✓
CO3	✓		✓			✓	✓		
CO4				✓				✓	✓
CO5			✓		✓	✓			

MEWEPEXX	**ADVANCED MATERIALS JOINING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To select the joining methods for non-metals.
- To understand joint integrity of advanced materials.
- To understand the need for joining of dissimilar materials.

Introduction - options for joining composites - joining of organic (polymer) matrix composites - joining of metal-matrix composites - joining of ceramic-matrix composites - joining carbon, graphite, or carbon-carbon composites - achieving maximum joint integrity between composites.

Basic joining for ceramics and glasses - mechanical joining of ceramics - adhesive bonding, brazing, welding and soldering of ceramics - other methods for joining ceramics to ceramics - welding and fusing of glasses - cementing and adhesive bonding of glasses - soldering of glasses and solder glasses.

The challenges of joining polymeric materials - joining of thermosetting polymers - joining of thermoplastic polymers - joining elastomeric polymers or elastomers - joining structural or rigid plastic foams - joining dissimilar polymers.

Joining of electronic materials - Joining of magnetic materials: processes used, joint design, precautions required, problems encountered, remedial steps to be taken, Testing and evaluation of joint qualities.

Need for joining dissimilar materials - joining metals to ceramics - joining metals to glasses - joining of metals to polymers - joining of metals to composites - joining of ceramics to polymers - joining of ceramics to composites.

REFERENCES

1. Messler, Warren Savage, "Joining of Advanced Materials", Butterworth-Heinemann publications, 1993.
2. Welding Handbook (Welding Processes), Volume II, 8th Edition, American Welding Society (AWS), 1991.
3. Matthews, F.L., Joining Fibre-Reinforced Plastics, London: Elsevier Applied Science, 1987.
4. Schwartz, Mel M., Ceramic Joining, Metals Park, Ohio: ASM International, 1990.

COURSE OUTCOMES

Upon successful completion of the course, student should be able to:

1. Understand the various methods for joining composite materials.
2. Improve the joint qualities of advanced materials.
3. Understand the difficulties in joining of newer materials.
4. Select an appropriate technique to join a newer material.
5. Choose suitable method for joining dissimilar materials

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓		✓	✓			✓		✓
CO2		✓			✓		✓		
CO3			✓			✓			✓
CO4	✓	✓		✓	✓		✓	✓	

MEWEPEXX	**RESIDUAL STRESSES AND DISTORTION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To impart a sound knowledge on mechanisms of residual stress and distortion.
- To study the factors affecting residual stresses.
- To study the different methods of residual stress and distortion measurements.

Residual stresses: types of residual stresses, mechanisms of residual stress formation, control of residual stresses and measurement and calculation of residual stresses, Residual Stress Pattern, Causes of residual stress- -residual stresses in different joints- Methods of relieve stress.

Factors affecting Residual stress: Effect of welding parameters on heat distribution-calculation of peak temperatures- thermal cycles- cooling rate and solidification- Residual stresses and their distribution in welds- influence of residual stresses in static and dynamic loading- Distortion in weldments.

Residuals Stress measurement Methods: Deep-Hole Drilling, Incremental Centre-Hole Drilling, Neutron Diffraction, Contour, Ring Core, Sachs Boring, Slitting, Synchrotron Diffraction, Ultrasound and X-ray Diffraction.

Distortion: types of distortion-longitudinal, transverse, angular, bowing, causes of distortion-heat input, restraint, inherent stresses in parent metal. Control of distortion-joint design, assembly procedure-pre-setting method: restrained method, welding procedure, welding process, type and size of electrode welding rod and wire, number of sequence of runs, size of deposit and welding position- welding current and welding speed, welding sequence and techniques- Other Techniques for Distortion Control.

Correction of distortion: manual, use of press, local heating - hot shrinkage, use of heat strip, use of heat triangle, Concept of residual stresses. Distortion in cutting-factors causing distortion, examples of distortion in cutting. Distortion control techniques in cutting-immersion in water, flushing behind the cut, simultaneous cutting, wedging, step cutting, welding behind the cut, locking the scrap.

REFERENCES

1. Baldev Raj, V. Shankar,A.K. Bhaduri, Welding Technology for Engineers, Eds. Narora Publishing House, 3 rd Reprint,2009
2. V. M. Radhakrishnan, "Welding Technology and Design", Revised Second Ed., New Age International Publishers.
3. J.G. Hicks, A Guide to Designing Welds –Woodhead Publising Ltd., 2001.
4. The Science and Pratice of Welding, Vol-1 : Welding Science and Technology, 1996.
5. Messler R.W., **"**Principles of Welding**",** John Wiley & Sons, 1999.

COURSE OUTCOMES

Upon successful completion of the course, student should be able to:

1. Understand the factors influencing residual stresses
2. Learn the various methods of measuring residual stresses
3. Understand the causes of residual stresses and distortion.
4. Estimate the residual stresses and distortion in the welded joints.
5. Design the weld joint with minimum residual stress and distortion.

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓	✓				✓			✓
CO2		✓	✓	✓					
CO3			✓		✓	✓	✓		✓
CO4	✓				✓		✓		
CO5			✓		✓	✓		✓	✓

MEWEPEXX	WELDING POWER SOURCES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To impart a sound understanding of electrical characteristics of welding power sources.
- To study the importance of various power sources.
- To measure the heat input during welding process.

Electrical discharges in gases. Discharge characteristic curve- Uses of electric arc- Three zones in arc - Cathode zone - Thermionic emission Work function for different metals - Plasma column –ionization potential of different gases – Distribution of potential across arc. Simplified voltage current characteristic of electric arc. Effect of arc length , shielding gas on arc voltage- Heat generation and distribution- forces affecting metal transfer-pinch effect- arc force due to shape of arc- modes of metal transfer.

Need for welding power source. Classification of welding power sources based on Construction type- Generators (Motor driven and engine driven) –Transformers (Moving coil Moving core) Rectifiers (Diode and SCR based) – Transistorised and Inverter type; Classification based on output characteristics- Drooping and Flat-Interaction of electric arc with different output characteristic of power source. Self-regulation of arc length with flat characteristic-Different methods of control of volt-ampere characteristics, OCV and short circuit current control, use of chokes and saturable reactors.

MMAW- Generators-rectifiers modern inverter –hot start ; TIG- DC Pulsed DC Square wave AC –Slope-up slope-down of current -HF unit; MIG/CO2 –Rectifiers -Electronic controls-spatter control- pulsed MIG- STT; SAW- DC AC Tandem arc; Plasma Arc- Transferred Arc and Non transferred arc; Duty cycle of welding power source –Estimating duty cycles for different welding currents; Arc starting methods for MMAW. TIG MIG SAW and Plasma ARC.

Measurement of welding current and voltage-welding speed- heat input calculations; Efficiency of different welding processes; Temperature measurement using RTD, Thermo couple and thermal chalk; Stress and strain measurement using strain gauges Quarter Half and Full bridge configurations; Arc welding analyser; Furnace temperature control ; Pre heat and post weld heat treatment equipments; Noise level measurement for hazards

Furnace temperature control Difference between mechanization and automation; Need for weld seam tracking- Methods of seam tracking- self guided- sensor based – using arc as sensor-laser sensor; Long seam – circseam welding – orbital welding of pipes- 3D curved joints in pipes; Introduction to robots- rectangular – cylindrical – gantry type - articulated arms

REFERENCES

1. Welding Handbook (Welding Processes), Volume II, 8th Edition, American Welding Society (AWS), 1991.
2. Richardson V. D., ‘ Rotating Electric Machinery and Transformer Technology’, Prentice Hall of India, 1978
3. Parmar R. S., ‘Welding Processes and Technology’, Khanna Publishers, 1997

4. Say M. G. Ed., Electrical Engineering Reference Book, 1973
5. Siemens Aklengesel, Chart Electrical Engineering Hand Book, 1987
6. S.V.Nadkarni, Modern Arc Welding Technology, Oxford-IBH Publisher, 1996.

COURSE OUTCOMES

Upon successful completion of the course, student should be able to:

1. Understand the electrical aspects of welding power sources.
2. Classify and characterize welding power sources.
3. Acquire knowledge on instruments used for testing power sources.
4. Measure the heat input and efficiency of different welding processes.
5. Select an appropriate power source for a specific application.

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓	✓			✓	✓		✓	
CO2		✓	✓	✓					
CO3	✓		✓		✓		✓		✓
CO4		✓		✓					
CO5		✓			✓		✓		✓

MEWEPEXX	**WELDING APPLICATION TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To study the applications of welding in process and fabrication industries.
- To impart sound knowledge on recent trends and developments in welding.
- To understand the need of field welding in pressure vessel applications.

Heat exchange, power cycle piping, super heaters, reheaters, economiser, auxiliary pipes, materials, processes and testing/inspection

Materials, processes, fabrication techniques and field welding for pressure vessel applications

Materials, processes, fabrication and construction, use of automatic welding and systems in automobile industry, automation

Oil and gas industry, materials, processes, fabrication, inspection and testing, case studies, recent trends and developments

Materials, processes, fabrication, inspection and testing, reasons for stringent quality control measures in nuclear industry

REFERENCES

1. American Welding Society, 'Guide for Steel Hull Welding', 1992
2. Gooch T. S., 'Review of Overlay Welding Procedure for Light Water Nuclear Pressure Vessels', American Welding Society, 1991
3. Winter Mark H., 'Materials and Welding in Off-Shore Constructions', Elsevier, 1986

4. Welding Institute Canada, 'Welding for Challenging Environments', Pergamon Press, 1996

COURSE OUTCOMES

Upon successful completion of the course, student should be able to:

1. Acquire sound knowledge on recent trends and developments in welding.
2. Understand the fabrication procedures employed in various industries.
3. Select appropriate material, welding process, consumable and procedures to fabricate a component.
4. Assure weld quality of welded components as per the standards.
5. Be familiar with various automatic welding systems

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓	✓				✓		✓	✓
CO2		✓		✓			✓		
CO3	✓		✓		✓	✓		✓	✓
CO4		✓	✓	✓					
CO5		✓					✓		✓

MEWEPEXX	**REPAIR WELDING & RECLAMATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To understand the various causes of failures and its prevention methods.
- To study the different repair welding techniques.
- To study the importance of hard facing techniques.

Engineering aspects of repair, aspects to be considered for repair welding, techno-economics, repair welding procedures for components made of steel casting and cast iron, full-mould process, AWA bath tub test for cast iron repair, special procedures to avoid post-repair stress relief heat treatment, half bead, temper bead techniques, usage of Ni base filler metals.

Damaged bends in gas transmission pipe lines, heat exchanger repair techniques – explosive expansion, plugging, etc., creep damaged high temperature components, repair of cracked petroleum pressure vessel/ reactor.

Types of wear, wear resistant materials, selection of materials for various wear applications, reclamation surfacing techniques. Selection of welding processes for reclamation.

Integrating repair/maintenance into on-going operation, radiation protection, steam generators repair, plugging.

Hardfacing, Cladding, Overlaying by shielded metal arc welding, gas metal arc welding, flux cored arc welding, gas tungsten arc welding, submerged arc welding, gas welding, plasma transferred arc welding, laser welding; consumables for weld surfacing, dilution measurement, microstructural features, Applications.

REFERENCES

1. "Recommended Practice for Repair Welding and Fabrication Welding of Steel Casting", Steel Foundry Research Foundation, 1981.
2. Nagendra Reddy A., "Maintenance Welding Made Easy", Jaico Publishing House, 1997.
3. Lim Cottrel C., The Welding Institute, "Welding Cast Irons", 1991.
4. "Weld Surfacing and Hardfacing", The Welding Institute, 1987.

COURSE OUTCOMES

Upon successful completion of the course, student should be able to:

1. Understand the significance of repair welding.
2. Select a suitable repair welding technique for specific damage.
3. Prescribe suitable consumables to enhance the life of the components.
4. Distinguish various types of wear
5. Gain knowledge about the methods of repairing pipe lines, pressure vessels, reactors etc.

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1		✓		✓			✓		✓
CO2	✓	✓	✓						
CO3				✓	✓		✓	✓	
CO4	✓			✓		✓			
CO5			✓		✓		✓		✓

MEWEPEXX	**HEALTH, SAFETY & ENVIRONMENTAL ASPECTS IN WELDING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To understand the needs of safety in welding.
- To study the causes and controlling of welding pollutions.
- To understand the techniques available to control the welding fumes.

Introduction to health and safety requirements Survey of safety and environmental aspects, risk assessment, Hazards of electric power, Electro-magnetic fields, Connecting of equipments, , Protective clothing and equipment, Health effects of grinding (vibration and dust).

Cylinder storage and handling, Oxygen environment enrichment, Health and safety requirements for each welding processes, Ergonomics, Commonly occurring accidents & Prevention Methods; Special risks for automated processes.

Welding fume emission, Exposure limits (Maximum Allowable Concentration) MAC and UEL (Upper Exposure Limit) values, Ventilation filters and fume extraction (type of equipment and airflow), Determination of acceptable emissions, Tests for measuring emissions, Noise levels and ear protection, Standards and regulations; Problems with shielding gases, Radiation and eye protection.

Pollution: Definition - Cause, effects and control measures of Air pollution - Water pollution - Soil pollution - Marine pollution- Noise pollution - Thermal pollution - Nuclear hazards - Solid waste Management: Causes, effects and control measures of urban and industrial wastes - Role of an individual in prevention of pollution. Environmental ethics: Issues and possible solutions - Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.

Wasteland reclamation - Consumerism and waste products - Environment Protection Act - Air (Prevention and Control of Pollution) Act - Water (Prevention and control of Pollution) Act - Wildlife Protection Act - Forest Conservation Act - Issues involved in enforcement of environmental legislation; Role of Information Technology in Environment and human health.

REFERENCES

1. Trivedi R.K., Handbook of Environmental Laws, Rules Guidelines, Compliances and Stadards, Vol I and II, Enviro Media (R)
2. Trivedi R. K. and P.K. Goel, Introduction to air pollution, Techno-Science Publication (TB)
3. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)
4. Mhaskar A.K., Matter Hazardous, Techno-Science Publication (TB)

COURSE OUTCOMES

Upon successful completion of the course, student should be able to:

1. Reduce the risks of accidents during welding
2. Select suitable protective methods to reduce welding emission
3. Awareness on health hazards to welders
4. Understand the prevention and control of air pollution
5. Be aware of Environment Protection Act

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓		✓	✓					✓
CO2		✓			✓	✓		✓	
CO3	✓		✓						
CO4		✓			✓	✓			✓
CO5		✓		✓	✓		✓		✓

MEWEPEXX	**LIFE ASSESSMENT OF WELDED STRUCTURES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To predict the life of the welded components.
- To study the different failure mechanisms.
- To evaluate the structural integrity of welded structures.

Historical evolution and operation of power plants and petrochemical plants – general description, temperature, pressures and materials, failure in plants, 0 –definition of failure.

Weld metal toughness evaluation methods, significance of Ductile to Brittle Transition Temperature (DBTT), Linear Elastic Fracture Mechanics (LEFM) approach, Elastic Plastic Fracture Mechanics (EPFM) approach, temper embrittlement, hydrogen embrittlement.

Mechanisms, parametric extrapolation techniques – LM, OSD, MII, MB and MCM, design rules, cumulative damage, crack growth models, Remaining Life Assessment (RLA) methodology for bulk and localized damages.

High and low cycle fatigue, Coffin-Manson relationship, creep fatigue interaction, effect of hold time, frequency strain concentration, environment, rupture ductility, damage rules and life prediction, design rules for creep fatigue (CF), linear damage summation, failure mechanism maps, thermal fatigue (TF), thermal-mechanical fatigue (TMF), thermal fatigue (TF), thermal-mechanical fatigue (TMF), thermal-mechanical fatigue life prediction, crack growth in fatigue.

Materials, damage mechanisms and RLA of boiler tubes, header, steam pipes, roots, steam casings, valves and steam chests, steam turbines blades, high temperature bolts, Non-destructive assessment methods for extent of creep damage, replication, creep pipes, principles of micro-thermography, effective temperature determination by implanting diffusion couples, life prediction of petroleum pressure vessel materials for hydrogen service, materials of construction, integrity consideration of pressure vessel shells and cladding, improved alloys of RLA techniques, Arkhausen Noise.

REFERENCES

1. Viswanathan. R, "Damage Mechanisms and Life Assessment of High Temperature Components", American Society for Metals, 1989.
2. Das. A. K. "Metallurgy of Failure Analysis", Tata McGraw Hill, 1993.
3. Karl Hauffe, "Oxidation of Metals", Plenum Press, 1981.
4. Viswanathan R. "Life Assessment and Improvement of Turbo-generators Rotors or Fossil Plants", Pergamon Press, 1985.

COURSE OUTCOMES

Upon successful completion of the course, student should be able to:

1. Understand the deformation and damage mechanics of welded structure.
2. Acquire knowledge on different life assessment tools.
3. Estimate the remaining life of the welded components.
4. Derive life assessment procedures for a specific welded component.
5. Utilize different techniques to enhance the life of the components.

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓		✓		✓	✓		✓	✓
CO2		✓		✓					
CO3	✓		✓			✓		✓	
CO4		✓		✓					
CO5					✓			✓	✓

MEWEOEXX	CORROSION ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To understand the basics of various forms of corrosion.
- To study the mechanisms of various corrosion and its prevention.
- To study the various types corrosion tests.

Corrosion Principle: Introduction – Electrochemical Aspects-Electrochemical Reactions – Polarization – Passivity. Environmental effects: Effect of Oxygen and Oxidizers – Effects of Velocity – Effects of Temperature – Effects of Corrosive Concentration – Effects of Galvanic Coupling

Primary Corrosion Types**:** Galvanic or two-metal corrosion, Pitting corrosion, Intergranular corrosion, Oxidation: Pilling - Bedworth Ratio – Electrochemical and Morphological Aspects of Oxidation – Oxide Defect Structure – Oxidation Kinetics – Effect of Alloying – Catastrophic Oxidation – Internal Oxidation.

Secondary Corrosion Types: Crevice corrosion: Environmental Factors – Mechanism – Combating Crevice Corrosion – Filiform Corrosion. Selective leaching: Dezincification: Characteristics – Dezincification, Erosion corrosion, Cavitation Damage – Fretting Corrosion. Stress corrosion: Crack Morphology – Stress Effects – Time to Cracking – Environmental Factors – Metallurgical Factors – Mechanisms.

Corrosion Testing: Introduction – Classification – Purpose – Materials and Specimens – Surface Preparation – Measuring and Weighing – Exposure Techniques – Duration – Planned-Interval Tests – Aeration – Cleaning Specimens After Exposure – Temperature – Standard Expressions form Corrosion Rate – Warren Test – Pitting – Stress Corrosion – NACE Test Methods – Slow-Strain-Rate Tests – Linear Polarization – AC Impedance-Small-Amplitude Cyclic Voltammetry.

Corrosion Prevention: Metals and Alloys – Metal Purification – Non metallics; Changing Mediums – Inhibitors Cathodic and anodic protection: Cathodic Protection – Anodic Protection – Comparison of Anodic and Cathodic Protection. Coatings: Metallic and other Inorganic Coatings – Organic Coatings – Corrosion Control Standards – Failure Analysis.

REFERENCES

1. Mars G. Fontana, Corrosion Engineering, Tata Mc Graw-Hill. New Delhi, 2008.
2. Philip A Schweitzer, Fundamentals of Corrosion, Taylor and Francis, USA, 2008.
3. Sydney, H., Avner, S.H., Introduction to Physical Metallurgy, McGraw Hill, 2008.

COURSE OUTCOMES

Upon successful completion of the course, student should be able to:

1. Assess the effects of environmental factors on corrosion.
2. Understand the mechanism of various corrosion methods.
3. Learn the various methods of corrosion testing
4. Select suitable prevention technique to combat corrosion.
5. Distinguish between primary and secondary corrosion types

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓		✓	✓					
CO2		✓			✓		✓		
CO3	✓			✓		✓			✓
CO4									✓
CO5	✓			✓		✓			✓

MEWEOEXX	**ADDITIVE MANUFACTURING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To understand the basics of additive manufacturing.
- To select the proper tools for additive manufacturing.
- To study the guidelines for process selection.

Introduction to Additive Manufacturing: Introduction to AM, AM evolution, Distinction between AM & CNC machining, Advantages of AM, AM process chain: Conceptualization, CAD, conversion to STL, Transfer to AM, STL file manipulation, Machine setup, build , removal and clean up, post processing.

Classification of AM processes: Liquid polymer system, discrete particle system, molten material systems, solid sheet system.

Design for AM: Motivation, DFMA concepts and objectives, AM unique capabilities, Exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers etc.

Guidelines for process selection: Introduction, selection methods for a part, challenges of selection, example system for preliminary selection, production planning and control AM Applications: Functional models, Pattern for investment and vacuum casting, Medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Re-manufacturing. Application examples for Aerospace, defense, automobile, Bio-medical and general engineering industries

Post processing of AM parts: Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques. Future Directions of AM: Introduction, new types of products and employment and digiproneurship.

REFERENCES

1. Chua Chee Kai, Leong Kah Fai, “Rapid Prototyping: Principles & Applications”, World Scientific, 2003.
2. Ian Gibson, David W Rosen, Brent Stucker., “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010

3. Ali K. Kamrani, Emand Abouel Nasr, "Rapid Prototyping: Theory & Practice", Springer,2006.
4. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 2001.

COURSE OUTCOMES

Upon successful completion of the course, student should be able to:

1. Understand the Importance of AM in Manufacturing.
2. Acquire sound knowledge in different AM Technologies.
3. Select suitable materials for AM.
4. Select Different methods for Post-processing of AM parts.
5. Understand the Future Directions of AM

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓	✓			✓		✓	✓	✓
CO2		✓	✓						
CO3			✓		✓			✓	
CO4		✓		✓					
CO5	✓		✓			✓		✓	✓

MEWEOEXX	**SURFACE MODIFICATION TECHNIQUES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To understand the needs of surface modification technique.
- To study the effect of process parameters of various thermal spray techniques.
- To study the applications of surface modification technique.

Welding Assisted Processes: Hardfacing, Cladding, Overlaying by Shielded metal arc welding, flux cored arc welding, submerged arc welding, gas tungsten arc welding, plasma transferred arc welding, laser beam welding techniques, consumables for weld surfacing, dilution measurement, microstructural features, Friction surfacing processes

Thermal Spray Techniques: Principles, Process Parameters, Coating Properties and Applications of: Flame Spraying (FS) - Spray and Fuse Coating (S&F) - Detonation-Gun Spraying (D-GUN) - High-Velocity Oxy-Fuel (HVOF) Spraying, High Velocity Air Fuel Spraying (HVAF), Arc Spraying (AS) - Atmospheric Plasma Spraying (APS) - Vacuum Plasma Spraying (VPS) - Cold-Gas Spraying Method (CGSM) - Electro Spark Coating (ESC)

Plating Processes: Fundamentals of Electro deposition, plating of nickel, chromium, tin and copper - pulsed plating – electroless plating - electrochemical conversion coating, metallizing, selective plating for repair, Hard anodizing.

Diffusion Processes: Principle of diffusion processes - Bording, Aluminising, Siliconising, Chromising, Sursulf - Selection of diffusion processes - Characteristics of diffused layer - micro structure and micro hardness evaluation - properties and applications.

Allied Processes: Laser beam hardening/ glazing, Laser Surface Melting, Laser Surface alloying, Laser Cladding, Electron beam hardening, Physical vapor deposition, Thermal evaporation, Arc vaporization, Sputtering, Ion plating - Chemical vapor deposition – Proprieties and applications of thin coatings.

REFERENCES

1. Kenneth G.Budinski, Surface Engineering for Wear Resistance, Prentice Hall, Englewood Cliff, 2000.
2. Surface Engineering, ASM Metals Handbook, Ohio, 2004
3. Emest Rabinowicz, Friction and Wear of Materials, John Wiley & Sons, New York, 2004.
4. R.S. Parmar, Welding technology and processes, Khanna publishers, New Delhi, 2006.
5. Lech Pawlowski, Science and Engineering of Thermal Spray Coatings, Springer Verlag Publications, Berlin, 2005.

COURSE OUTCOMES

Upon successful completion of the course, student should be able to:

1. Improve the surface properties through surface modification techniques.
2. Understand the principles of various surface modification techniques
3. Enhance the life of the components through advanced surface modification process.
4. Select suitable surface modification technique for specific applications.
5. Understand the various diffusion processes

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓			✓					
CO2		✓			✓	✓		✓	✓
CO3			✓						
CO4		✓				✓			✓
CO5		✓		✓				✓	

MEWEOEXX	**FINITE ELEMENT ANALYSIS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To understand the basics of finite element method.
- To study about the different solving methods.
- To understand the application of FEM in welding.

Historical Background – Basic concepts of FEM - Boundary conditions-Fundamentals of stress-strain relationships, Strain vs Displacement relations-Temperature effects, Weighted residual methods – Introduction to variational formulation :Ritz method – Galerkin method – Solution of algebraic equations- Gaussian elimination- Significance and applications of FEM.

One dimensional problems, Finite element modeling- Coordinates and shape functions - Interpolation - Derivation and assembly of finite element equations - Potential energy

approach - Assembly of global stiffness matrix and load vector - Treatment of Boundary conditions- Quadratic shape functions- Example problems.

Constant strain triangular element- axisymmetric solids subjected to axisymmetric loads - two dimensional isoparametric elements-numerical integration – Poissons and Laplaces equation – Element Matrices and Vectors – Lagrangian Interpolation Polynomials- Illustrative examples.

Applications in welding: Data acquisition in Lab view, Incorporation of latent heat- Transient analysis, Time stepping procedure-Predication of grain structure- Models for Welding heat sources- Double ellipsoidal model, Gaussian surface model.

Computer Implementations: An overview of commercial packages- Preprocess- Mesh generation, Adapative meshing, boundary conditions - Input of data- Material properties- Updating the values - remeshing - Post processing – Validation - One dimensional heat conduction: Simple heat transfer problems

REFERENCES

1. Segerline L.J., "Applied Finite Element Analysis", John Wiley, 1984.
2. Rao. S.S., "Finite Element Method in Engineering", Pergamon Press, 1996.
3. Chandrupatla and Belagundu, "Finite Elements in Engineering", PHI, 2001.
4. John A. Goldak, Mehdi Akhlaghi, "Computational Welding Mechanics", Springer, 2011.
5. Cook, Rober Davis etal., "Concepts and Applications of Finite Element Analysis", John Wiley and Sons, 1999.
6. Buchaman. G.R., Schaum's "Outline of Finite Element Analysis", McGraw-Hill Company, 1994.

COURSE OUTCOMES

Upon successful completion of the course, student should be able to:

1. Understand the basic concept and applications of FEM.
2. Analyze the various stresses of acting on the welded joint through FEM.
3. Estimate heat distribution during welding by FEM.
4. Evaluate effect of input parameters on the output responses.
5. Apply a suitable FE method for a specific problem

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	✓	✓		✓	✓		✓		✓
CO2		✓	✓						
CO3			✓		✓		✓		✓
CO4				✓					
CO5	✓	✓			✓	✓		✓	✓

MEWEOEXX	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To discuss the different views of quality and to appreciate the importance of product quality;
- To provide a knowledge understand a framework summarizing the philosophical elements and generic tools of TQM;
- To provide an understanding of the role of quality control and Acceptance sampling plans in organizations.

Concepts of TQM – Dimensions of Quality - Deming, Crosby and Juran's Philosophies – Barriers to TQM - Quality system – ISO 9000:2000, ISO 14000 Quality system standards - Quality costs, Seven tools for Quality Control, Seven tools for Quality management, Quality Function Deployment (QFD) – Taguchi loss function

Statistical Process Control: Control charts for attributes and count of defects – p chart, np chart, c chart, u chart. $\bar{X}$ chart, R chart, σ chart – process capabilities studies (C_p and C_{pk}) – Concept of Six sigma.

Special control charts – Group control chart, sloping control chart, moving averages and moving ranges control charts, coefficient of variation control chart.

Acceptance sampling plans for attributes: Concepts – Difference between inspection and quality control - single sampling plan - OC curve.

Reliability Engineering: Definition – Bath tub curve - MTBF – MTTF - System reliability with components in series, parallel– FTA, FMECA.

REFERENCES

1. Montgomery D.C., Introduction to Statistical Quality Control, John Wiley, 1994.
2. Gupta R.C., Statistical Quality Control, Khanna Pub., 1998.
3. Amitava Mitra, "Fundamentals of quality control and improvement", prentice hall, 2nd edition, 1998
4. Besterfield, "Total Quality Management", Pearson Education, 2nd Edition, 2003.
5. Mahajan,M., " Statistical Quality Control", dhanpat rai & co.,pvt ltd, 2010
6. Srinath L.S., Concepts in Reliability Engineering, Eastwest Press Ltd., 1991. IS 397 Part I, II and III, IS 2500

COURSE OUTCOMES

Upon successful completion of the course, student should be able to:

1. Understand the core features of the total quality management in terms of various dimensions of quality.
2. Measure the cost of poor quality and process effectiveness and efficiency to track performance quality and to identify areas for improvement
3. Develop an understanding on quality management philosophies and frameworks
4. Develop the ability to apply the tools of quality control and quality management.
5. Understand proven methodologies to enhance management processes, such as benchmarking and business process reengineering, lean manufacturing.

Mapping of COs with POs									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO5**	**PO5**	**PO5**	**PO5**
CO1	✓		✓		✓	✓		✓	✓
CO2		✓		✓					
CO3	✓		✓			✓		✓	
CO4		✓		✓					✓
CO5			✓		✓		✓		✓

AUDIT COURSES

MFWEACXX	**ENGLISH FOR RESEARCH PAPER WRITING**	**L**	**T**	**P**
		2	**0**	**0**

COURSE OBJECTIVES

Students will be able to:

- Understand that how to improve your writing skills and level of readability
- Learn about what to write in each section
- Understand the skills needed when writing a title
- Ensure the good quality of paper at very first-time submission

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,

Kkills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

REFERENCES

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book .
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

MFWEACXX	DISASTER MANAGEMENT	L	T	P
		2	0	0

COURSE OBJECTIVES

Students will be able to:

- Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

Introduction Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

Repercussions of Disasters And Hazards: 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.

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

Disaster Preparedness and Management: 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.

Risk Assessment: 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.

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

REFERENCES

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, Pardeep Et.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.

MFWEACXX	SANSKRIT FOR TECHNICAL KNOWLEDGE	L	T	P
		2	0	0

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

Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences, Order, Introduction of roots, Technical information about Sanskrit Literature, Technical concepts of Engineering - Electrical, Mechanical, Architecture, Mathematics

REFERENCES

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

Students will be able to

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

MFWEACXX	VALUE EDUCATION	L	T	P
		2	0	0

COURSE OBJECTIVES

Students will be able to

- Understand value of education and self- development
- Imbibe good values in students
- Let the should know about the importance of character

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

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

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 labour. 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

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.

REFERENCES

1. Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

COURSE OUTCOMES

Students will be able to

1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality

MFWEACXX	CONSTITUTION OF INDIA	L	T	P
		2	0	0

COURSE OBJECTIVES

Students will be able to:

- 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.

History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working)

Philosophy of the Indian Constitution: Preamble Salient Features

Contours of Constitutional Rights & Duties: 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.

Organs of Governance: Parliament, Composition, Qualifications and Disqualifications Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions

Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy

Election Commission: 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.

REFERENCES

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

Students will be able to:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. 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.
4. Discuss the passage of the Hindu Code Bill of 1956.

MFWEACXX	PEDAGOGY STUDIES	L	T	P
		2	0	0

COURSE OBJECTIVES

Students will be able 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.

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions**.** Overview of methodology and Searching.

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

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.

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

Research gaps and future directions: Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

REFERENCES

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.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

COURSE OUTCOMES

Students will be able to understand:

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

MFWEACXX	STRESS MANAGEMENT BY YOGA	L	T	P
		2	0	0

COURSE OBJECTIVES

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

Definitions of Eight parts of yog. (Ashtanga) Yam and Niyam.
Do`s and Don't's in life.

(i) Ahinsa, satya, astheya, bramhacharya and aparigraha
(ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

Asan and Pranayam

(i) Various yog poses and their benefits for mind & body
(ii) Regularization of breathing techniques and its effects-Types of pranayama

REFERENCES

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

COURSE OUTCOMES:

Students will be able to:

1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

MFWEACXX	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L	T	P
		2	0	0

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

Neetisatakam-Holistic development of personality

- 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)

Approach to day to day work and duties.
Shrimad Bhagwad Geeta :

- 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.

Statements of basic knowledge.
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

REFERENCES

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

COURSE OUTCOMES

Students will be able to

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