M.I.E.T. ENGINEERING COLLEGE

(AUTONOMOUS)

(Approved by AICTE, New Delhi and Affiliated to Anna University, Chennai)
Accredited by NBA (CIVIL, CSE, ECE, EEE & MECH)
Accredited with 'A+' grade by NAAC
(An ISO 9001:2015 Certified Institution)
(Recognized by UGC under section 2(f) & 12(B) of UGC Act, 1956)
TRICHY - PUDUKKOTTAI MAIN ROAD, TRICHY - 620 007

DEPARTMENT OF MECHANICAL ENGINEERING

CURRICULUM AND SYLLABUS

M.E. MANUFACTURING ENGINEERING
(Regulations 2024)

Vision

Establish a globally recognized school of Excellence in the field of Mechanical Engineering.

Mission

- Impart quality education in Mechanical Engineering through effective teaching – learning techniques.
- Provide necessary infrastructure and facilities for the student's personal and professional growth.
- Expose to specialised Mechanical Engineering domains to harness evolving technologies.
- Create awareness in ethical practices followed internationally.

Program Outcomes (POs)

1. An ability to independently carry out research/investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at level higher than the requirements in the appropriate bachelor program.
4. An ability to design systems, components, or processes meeting specified needs for the manufacturing industry and to improve its efficiency.
5. To use modern equipment and problem-solving tools for improving the manufacturing systems and processes in all aspects including technical, financial and management.
6. To pursue higher studies / pursue their career or entrepreneur in manufacturing and allied industries.

Program Educational Objectives (PEOs)

1. To prepare students to know and utilize the modern manufacturing facility in order to improve productivity.
2. To impart skills to use smart machines and apply latest technology in manufacturing field to innovate production process that will be useful to the Society.
3. To imbibe skills for integrated problem-solving techniques to optimize the Manufacturing resources for sustainable development.

PO-PEO Mapping

Program Educational Objectives	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
PEO1	3	-	3	2	3	2
PEO2	2	2	-	3	3	2
PEO3	1	-	2	3	3	2

1-Low, 2 -Medium, 3- High, '-'- No correlation

CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS (REGULAR) CURRICULUM AND SYLLABUS
SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
THEORY								
1.	24MF1101	Machining Science	FC	3	0	0	3	3
2.	24MF1102	Additive Manufacturing	PCC	3	0	0	3	3
3.	24MF1103	Advances in Manufacturing Processes	PCC	3	0	0	3	3
4.	24MF1104	Advanced Materials and Technologies	PCC	3	0	0	3	3
5.	24MF1105	Design for Manufacture and Assembly	PCC	3	0	0	3	3
6.	24RE1101	Research Methodology and IPR	RMC	2	0	0	2	2
PRACTICAL								
7.	24MF1201	Manufacturing Engineering Laboratory	PCC	0	0	4	4	2
8.	24MF1501	Technical Seminar*	EEC	0	0	2	2	0
							Total	**19**

*Non-credit course

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
THEORY								
1.	24MF2101	Design and Analysis of Experiments	PCC	3	0	0	3	3
2.	24MF2102	Materials Testing and Characterization Techniques	PCC	3	0	0	3	3
3.	24MF2103	Mechanics of Metal Forming	PCC	3	0	0	3	3
4.	24MF2104	Precision Engineering	PCC	3	0	0	3	3
5.	24RE2101	Scientific Report Writing	RMC	2	0	0	2	2
6.	-	Professional Elective I	PEC	3	0	0	3	3
7.	-	Professional Elective II	PEC	3	0	0	3	3
PRACTICAL								
8.	24MF2201	Metal Forming and Simulation Laboratory	PCC	0	0	4	4	2
9.	24MF2202	Advanced Manufacturing Processes Laboratory	PCC	0	0	4	4	2
							Total	**24**

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
THEORY								
1.	-	Professional Elective III	PEC	3	0	0	3	3
2.	-	Professional Elective IV	PEC	3	0	0	3	3
3.	-	Professional Elective V	PEC	3	0	0	3	3
4.	-	Open Elective	OEC	3	0	0	3	3
PRACTICAL								
5.	24RE3201	Research Article Review	RMC	0	0	4	4	2
6.	24MF3501	Project Work Phase - I	EEC	0	0	12	12	6
7.	-	Summer Internship*	EEC	0	0	0	0	0
							Total	**20**

***Two weeks summer Internship will be done during II semester summer vacation and same will be evaluated in III semester**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
PRACTICAL								
1.	24MF4501	Project Work Phase - II	EEC	0	0	24	24	12
							Total	**12**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 75

FOUNDATION COURSE (FC)

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
THEORY								
1.	24MF1101	Machining Science	FC	3	0	0	3	3
							Total	**3**

PROFESSIONAL CORE COURSES (PCC)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24MF1102	Additive Manufacturing	PCC	3	0	0	3	3
2.	24MF1103	Advances in Manufacturing Processes	PCC	3	0	0	3	3
3.	24MF1104	Advanced Materials and Technologies	PCC	3	0	0	3	3
4.	24MF1105	Design for Manufacture and Assembly	PCC	3	0	0	3	3
5.	24MF1201	Manufacturing Engineering Laboratory	PCC	0	0	4	4	2
6.	24MF2101	Design and Analysis of Experiments	PCC	3	0	0	3	3
7.	24MF2102	Materials Testing and Characterization Techniques	PCC	3	0	0	3	3
8.	24MF2103	Mechanics of Metal forming	PCC	3	0	0	3	3
9.	24MF2104	Precision Engineering	PCC	3	0	0	3	3
10.	24MF2201	Metal forming and Simulation Laboratory	PCC	0	0	4	4	2
11.	24MF2202	Advanced Manufacturing Processes Laboratory	PCC	0	0	4	4	2
							Total	**30**

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24RE1101	Research Methodology and IPR	RMC	2	0	0	2	2
2.	24RE2101	Scientific Report Writing	RMC	2	0	0	2	2
3.	24RE3201	Research Article Review	RMC	0	0	4	4	2
							Total	**6**

PROFESSIONAL ELECTIVE COURSES (PEC)
SEMESTER II, ELECTIVES – I & II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24MF2301	Machine Tool Design	PEC	3	0	0	3	3
2.	24MF2302	Plasticity and Metal Forming	PEC	3	0	0	3	3
3.	24MF2303	Product Design and Development	PEC	3	0	0	3	3
4.	24MF2304	Surface Engineering	PEC	3	0	0	3	3
5.	24MF2305	Tribology	PEC	3	0	0	3	3
6.	24MF2306	Robot Design and Programming	PEC	3	0	0	3	3
7.	24MF2307	Micro and Nano Manufacturing Processes	PEC	3	0	0	3	3
8.	24MF2308	Advanced Joining Technologies	PEC	3	0	0	3	3
9.	24MF2309	Theory of Elasticity and Plasticity	PEC	3	0	0	3	3
10.	24MF2310	Materials Technology	PEC	3	0	0	3	3
11.	24MF2311	Advanced Casting and Welding Technologies	PEC	3	0	0	3	3
12.	24MF2312	Polymers and Composite Materials	PEC	3	0	0	3	3

SEMESTER III, ELECTIVES – III, IV & V

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24MF3301	Digital Manufacturing	PEC	3	0	0	3	3
2.	24MF3302	Intelligent Manufacturing Systems	PEC	3	0	0	3	3
3.	24MF3303	Finite Element Methods in Manufacturing	PEC	3	0	0	3	3
4.	24MF3304	Industrial Machine Vision	PEC	3	0	0	3	3
5.	24MF3305	Smart Manufacturing Technologies	PEC	3	0	0	3	3
6.	24MF3306	Simulation Modelling of Manufacturing Systems	PEC	3	0	0	3	3
7.	24MF3307	3D Printing Technology	PEC	3	0	0	3	3
8.	24MF3308	Artificial Intelligence in Manufacturing	PEC	3	0	0	3	3
9.	24MF3309	Computer Aided Product Design	PEC	3	0	0	3	3

10.	24MF3310	Data Analytics	PEC	3	0	0	3	3
11.	24MF3311	Internet of Things for Manufacturing	PEC	3	0	0	3	3
12.	24MF3312	Industrial Automation	PEC	3	0	0	3	3
13.	24MF3313	Productivity Management	PEC	3	0	0	3	3
14.	24MF3314	Enterprise Resource Planning	PEC	3	0	0	3	3
15.	24MF3315	Manufacturing Management	PEC	3	0	0	3	3
16.	24MF3316	Product Life Cycle Management	PEC	3	0	0	3	3
17.	24MF3317	Industrial Safety	PEC	3	0	0	3	3
18.	24MF3318	Operational Research	PEC	3	0	0	3	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24MF1501	Technical Seminar	EEC	0	0	2	2	0
2.	24MF3501	Project Work Phase - I	EEC	0	0	12	12	6
3.	24MF4501	Project Work Phase - II	EEC	0	0	24	24	12
							Total	**18**

24MF1101 **MACHINING SCIENCE** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To acquaint the student with fundamental principles of machining processes.
- To make the students to explore tool materials, wear mechanisms, and tool life.
- To learn the basics of the dynamics of machining, mechanisms of grinding, including chatter and vibration.

UNIT I MECHANICS OF MACHINING PROCESSES **9**

Orthogonal and Oblique cutting, Mechanics of Chip formation: Types of chips, chip-breakers, Chip reduction coefficient, shear angle, shear strain, Built- Up-Edge and its effect in metal cutting, Merchant's analysis of metal cutting process - Various forces, power and specific energy in cutting, Problems on Tool Geometry and Mechanics of Machining, Theories of Metal Cutting: Ernst & Merchant, theory, Modified Merchant's theory, Lee & Shaffer Theory, Chip-tool Natural Contact Length — Hahn's Analysis Stress distribution at Chip-Tool Interface - Zorev's Analysis, Machining with controlled contact cutting.

UNIT II THERMAL ASPECTS IN MACHINING **9** Heat distribution in machining-effects of various parameters on temperature-methods of temperature measurement in machining- Factors Affecting Cutting Temperatures- Analytical Models for Steady-State Temperatures, Temperatures in Interrupted Cutting, hot machining, Thermal Expansion, and Cutting fluid – properties – types of cutting fluids –Selection of cutting fluids.

UNIT III TOOL MATERIALS, TOOL LIFE AND TOOL WEAR **9**

Essential requirements of tool materials-development of tool materials-ISO specification for inserts and tool holders- Tool geometry - Mechanisms of tool wear – Abrasion – Adhesion – Diffusion – Types of tool wear – flank wear – crater wear – Tool life – Tool life equations - factors affecting tool life – Illustrative problems- conventional and accelerated tool life tests-concept of machinability index-economics of machining

UNIT IV WEAR MECHANISMS AND CHATTER IN MACHINING **9**

Processing and Machining – Measuring Techniques, Tool Wear: Material Considerations, Tool Life Testing, Tool Life Equations, Reasons for failure of cutting tools and forms of wear-mechanisms of wear-chatter in machining-factors affecting chatter in machining-types of chatter-mechanism of chatter, Experimental Machine Tool Vibration Analysis.

UNIT V MECHANISM OF MACHINING AND GRINDING **9**

Drill Geometry and Mechanics of Drilling Process, Geometry of Milling Cutters and Mechanics of Milling process, Mechanics of Grinding (plunge grinding and surface grinding), Grinding wheel wear. Oblique Cutting: Mechanics of Oblique Cutting, Tooth Machining Methods-calculation of cutting forces and design of work holding devices.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Analyze the mechanics of material removal processes, including chip formation and shear zone mechanics.

CO2: Understand the sources of heat generation during machining and its effects on material properties and tool life.

CO3: Develop strategies to optimize tool life and minimize wear through cutting conditions and tool material selection.

CO4: Evaluate the effect of process parameters on wear and chatter, and optimize machining conditions to minimize these effects.

CO5: Understand the fundamental mechanisms involved in material removal in both machining and grinding processes.

TEXT BOOKS

1. Bhattacharya.A, Metal Cutting Theory and practice, Central Book Publishers, India, 2012.
2. Boothroid D.G. & Knight W.A, Fundamentals of machining and machine tools, Marcel Dekker, Newyork, 2005.
3. Shaw.M.C, Metal cutting principles, Oxford Clare don press, 2012.

REFERENCE BOOKS

1. B L Juneja and G S Sekhon, “Fundamentals of Metal Cutting and Machine Tools”, 2017.
2. Rao. P.N, "Manufacturing Technology-Metal Cutting and Machine Tools", Tata McGraw-Hill, New Delhi, 2003.
3. Wilson. FW, "Fundamentals of Tool Design" ASTME PHI 2010.
4. Roy. A.Lindberg, 'Process and Materials of Manufacture", Fourth Edition, PHI/Pearson Education 2006.
5. Winston A. Knight and Geoffrey Boothroyd, "Fundamentals of Machining and Machine Tools", Taylor & Francis Group, 2005.

Mapping of COs and POs

COs	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	2	-	-
CO2	3	2	3	3	-	-
CO3	3	3	3	3	-	-
CO4	3	3	3	3	-	-
CO5	3	3	3	3	-	-
AVG	3	3	3	3	-	-

1-Low, 2-Medium, 3-High, ‘-’- No correlation

24MF1102 ADDITIVE MANUFACTURING L T P C
3 0 0 3

COURSE OBJECTIVES

- To gain knowledge on powder based additive manufacture.
- To familiarize in reverse engineering.
- To gain knowledge on liquid based additive manufacture.

UNIT I INTRODUCTION TO ADDITIVE MANUFACTURING 9

Need - Development of AM systems – AM process chain - Impact of AM on Product Development - Virtual Prototyping- Rapid Tooling – RP to AM -Classification of AM processes-Benefits- Applications.

UNIT II REVERSE ENGINEERING AND CAD MODELLING 9

Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modelling techniques: Wire frame, surface and solid modelling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation-Software for AM- Case studies.

UNIT III LIQUID AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS 9

Stereolithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications. Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modelling (FDM): Principle, details of processes, process variables, types, products, materials and applications. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

UNIT IV POWDER BASED ADDITIVE MANUFACTURING SYSTEMS 9

Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies.

UNIT V OTHER ADDITIVE MANUFACTURING SYSTEMS 9

Three-dimensional Printing (3DP): Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing (SDM), Ballastic Particle Manufacturing (BPM), Selective Laser Melting, Electron Beam Melting.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Understand the concept of additive manufacturing.
CO2: Understand the reverse engineering concept.
CO3: Understand the liquid and solid method of additive manufacturing process.
CO4: Understand the powder based additive manufacturing system.
CO5: Utilize the 3D Printing Technique.

TEXT BOOKS

1. Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", second edition, World Scientific Publishers, 2010.
2. Gebhardt, A., "Rapid prototyping", Hanser Gardener Publications, 2003.
3. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.

REFERENCE BOOKS

1. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.
2. Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
3. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2011.
4. Dr. R.B. Choudhary, "Additive Manufacturing", Khanna Publishers, First Edition 2022.
5. Mukesh Kumar, Additive Manufacturing Technologies, I K International Publishing House Pvt. Ltd., 2021.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	-	-	-	-
CO2	3	3	-	-	-	-
CO3	3	2	-	-	-	-
CO4	3	2	-	-	-	-
CO5	3	3	-	-	-	-
AVG	3	2	-	-	-	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF1103 ADVANCES IN MANUFACTURING PROCESSES L T P C
3 0 0 3

COURSE OBJECTIVES

- To develop the specialized knowledge and skill in advanced manufacturing processes using the principles and methods of engineering analysis.
- To inculcate knowledge about the importance of optimizing process parameters for newly developed engineering materials used in industries and research Institutes.
- To gain knowledge on different techniques used in Micro and Nano manufacturing.

UNIT I ADVANCED TECHNIQUES FOR MATERIAL PROCESSING 9

STEM: shape tube electrolytic machining, EJT: Electro Jet machining, ELID electrolytic in process dressing, ELID process, ECH: Electro-chemical Etching laser-based heat treatment.

UNIT II PRECISION MACHINING 9

Electro chemical Machining- Ultra Precision turning and grinding- Chemical Mechanical Polishing (CMP) - Partial ductile mode grinding-Ultra precision grinding- Binderless wheel – Free form optics. Aspherical surface generation Grinding wheel- Design and selection of grinding wheel-High-speed grinding- High-speed milling- Diamond turning.

UNIT III ADVANCES IN METAL FORMING 9

Orbital forging, Isothermal forging, Warm forging, Overview of Powder Metal techniques – Hot and Cold isostatic pressing - high speed extrusion, rubber pad forming, Hydroforming, Superplastic forming, Peen forming-micro blanking –Powder rolling – Tooling and process parameters.

UNIT IV ADVANCED WELDING, CASTING AND FORGING PROCESSES 9

Friction stir welding-introduction, tooling, temperature distribution and resulting melt flow, processes parameters analysis, diffusion welding, advanced die casting – tooling and process parameters, vacuum die casting, squeeze casting.

UNIT V NANO FABRICATION 9

Nano fabrication process - Nano machining techniques – Top / Bottom-up Nano fabrication techniques - Sub micron lithographic technique, conventional film growth technique, Chemical etching, Quantum dot fabrication techniques – MOCVD – Epitaxy techniques.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Model the material removal in various modern manufacturing processes.

CO2: Understand the precision machining for achieving the maximum material removal rate and best quality of machined surface.

CO3: Analysis the advancement in metal forming processes.

CO4: Understand the various advanced welding, casting and forging process.

CO5: Demonstrate the knowledge on nano-fabrication techniques.

TEXT BOOKS

1. Benedict, G.F. "Non Traditional manufacturing Processes", CRC press, 2011.
2. Madou, M.J., Fundamentals of Micro fabrication: The Science of Miniaturization, Second Edition, CRC Press (ISBN: 0849308267), 2006.
3. Mc Geough, J. A.,"Advanced methods of Machining", Springer, 2011.

REFERENCE BOOKS

1. Narayanaswamy, R., Theory of Metal Forming Plasticity, Narosa Publishers, 2000.
2. Pandey, P.S. and Shah.N. "Modern Manufacturing Processes", Tata McGraw Hill, 2017.
3. Serope Kalpakjian., "Manufacturing Engineering and Technology" Pearson Education, 2018.
4. Sukhdeep Singh Dhami, B. S. Pabla, "Advances in Manufacturing Technology", Publisher : Taylor & Francis Ltd; 1st edition, 2022.
5. M. Adithan, A. A. A. Zainal, Advances in Manufacturing Processes, CRC Press, 2018.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	-	-	-
CO2	2	2	2	-	-	-
CO3	3	2	2	-	-	-
CO4	2	3	2	-	-	-
CO5	3	2	2	-	-	-
AVG	3	2	2	-	-	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF1104 ADVANCED MATERIALS AND TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES

- To get a strong understanding of the properties and applications of advanced materials across various industries.
- To learn the characterization techniques for evaluating material performance and behavior.
- To study the properties and performance of advanced materials and their applications in various industries.

UNIT I ELASTIC AND PLASTIC BEHAVIOR 9

Elasticity in metals and polymers Anelastic and visco-elastic behaviour – Mechanism of plastic deformation and nonmetallic shear strength of perfect and real crystals – Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, poly phase mixture, precipitation, particle, fibre and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behavior – Super plasticity – Deformation of non-crystalline materials.

UNIT II FRACTURE BEHAVIOUR **9**

Griffith's theory, stress intensity factor and fracture toughness – Toughening mechanisms – Ductile, brittle transition in steel – High temperature fracture, creep – Larson Miller parameter – Deformation and fracture mechanism maps – Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law. Effect of surface and metallurgical parameters on fatigue – Fracture of non-metallic materials – Failure analysis, sources of failure, procedure of failure analysis.

UNIT III SELECTION OF MATERIALS **9**

Motivation for selection, cost basis and service requirements – Selection for mechanical properties, strength, toughness, fatigue and creep – Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing – Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications – Computer aided materials selection.

UNIT IV MODERN METALLIC MATERIALS **9**

Dual phase steels, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) Steel, Maraging steel, Nitrogen steel – intermetallic, Ni and Ti aluminides – smart materials, shape memory alloys – Metallic glass and nano crystalline materials.

UNIT V NON-METALLIC MATERIALS **9**

Polymeric materials – Formation of polymer structure – Production techniques of fibers, foams, adhesives and coating – structure, properties and applications of engineering polymers – Advanced structural ceramics, WC, TIC, TaC, Al2O3, SiC, Si3N4 CBN and diamond – properties, processing and applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Analyze elastic and plastic behavior of different materials.
CO2: Analyze the fracture behavior of materials.
CO3: Select the suitable materials for specific application.
CO4: Design the material selection strategies based on mechanical properties.
CO5: Analyze the Nonmetallic materials properties.

TEXT BOOKS

1. Ashby M.F., Material Selection in Mechanical Design, 3rd Edition, Butter Worth 2005.
2. George E.Dieter, Mechanical Metallurgy, McGraw Hill, 1988.
3. Charles, J. A., Crane, F.A.A. and Fumess, J.A.G., Selection and use of engineering materials, (3rd edition), Butterworth-Heiremann, 2001.

REFERENCE BOOKS

1. ASM Hand book, Vol.11, Failure Analysis and Prevention, ASM, 2002.
2. Flinn, R.A., and Trojan, P.K., Engineering Materials and their Applications, (4th Edition) Jaico, 1999.
3. Thomas H. Courtney, Mechanical Behaviour of Materials, (2nd edition), McGraw Hill, 2000.
4. Advanced Materials and Technologies, Mr. M. Kannan, Dr. M. Tamil Selvi, Dr. K.

Bindu Kumar, Mr. Asif Ansari, and Dr. V. V. Kamesh, Cosmas Scientific Publications, 2023.

5. Ghosh, Asok Kumar, Advanced Non-conventional Materials and Technologies, Tata Mc Graw-Hill Education, 2016.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	-	-	-	-
CO2	2	2	-	-	-	-
CO3	3	3	-	-	-	-
CO4	2	2	-	-	-	-
CO5	3	3	-	-	-	-
AVG	3	3	-	-	-	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF1105 DESIGN FOR MANUFACTURE AND ASSEMBLY L T P C
3 0 0 3

COURSE OBJECTIVES

- To make the students effectively to achieve an understanding the requirement of tolerances.
- To familiarize the various tools used design the system.
- To gain knowledge on design for assembly and manufacturing considerations.

UNIT I TOLERANCES AND DFM APPROACH 9

Dimensional chain analysis, Geometric tolerances: applications, geometric tolerancing for manufacture as per IS and ASME Y 14.5 standard; surface finish, Tolerance stackup calculations; Review of relationship between attainable tolerance grades and different machining, Design Impact on Cost, Design for "X" – DFM approach, DFM Framework, Material and Process Evaluation, General DFM Guidelines, Machining and Casting Guidelines and Examples, Minimize Finishing Requirements. Computer applications for DFMA.

UNIT II FORM DESIGN OF CASTINGS, WELDMENTS, FORGING AND SHEET METAL COMPONENTS 9

Materials choice, Influences of materials, Space factor, Size, Weight- Surface properties and production method on form design. Redesign of castings based on parting line considerations, minimizing core requirements, redesigning cast members using Weldments-Form design aspects in Forging and sheet metal components.

UNIT III DESIGN FOR ASSEMBLY - MACHINING CONSIDERATIONS 9

Design features to facilitate machining, Drills, milling cutters, Keyways, Doweling procedures, Counter sunk screws, Reduction of machined area, Simplification by separation, Simplification by amalgamation, Design for machinability, Design for economy, Design for clampability, Design for accessibility, Design for assembly. Redesign For Manufacture, Design features to facilitate machining: datum features, functional and manufacturing. Component design, machining

considerations, redesign for manufacture.

UNIT IV DFMA TOOLS **9**

Rules and methodologies used to design components for manual, automatic and flexible assembly, traditional design and manufacture Vs concurrent engineering, DFA index, poke -yoke, lean principles, six sigma concepts, DFMA as the tool for concurrent engineering, three DFMA criteria for retaining components for redesign of a product; design for manual assembly; design for automatic assembly- Computer-aided design for assembly using software.

UNIT V DESIGN FOR THE ENVIRONMENT **9**

Introduction, Environmental objectives, Global issues, Regional and local issues, Basic DFE methods, Design guidelines, Weighted sum assessment method, Lifecycle assessment method, Techniques to reduce environmental impact, Design to minimize material usage, Design for disassembly, Design for Recyclability, Design for remanufacture, Design for energy efficiency, Design to regulations and standards.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Understand the tolerances and DFM approach.
CO2: Apply the forms designs for various components.
CO3: Analyze the design consideration for design of assembly.
CO4: Identify the various tools for DFMA.
CO5: Design the components by considering different environment.

TEXT BOOKS

1. Alex Kruli kowski, “Fundamentals GD&T”, Delmar Thomson Learning, 1997.
2. C.M. Creveling, “Tolerance Design – A handbook for Developing Optimal Specifications”, Addison – Wesley, 1997.
3. James D. Meadows, ‘Geometric Dimensioning and Tolerancing”, Marcel Dekker Inc.1995.

REFERENCE BOOKS

1. James G. Bralla, “Handbook of Product Design for Manufacturing”, McGraw Hill, 1986.
2. Oliver R. Wade, “Tolerance Control in Design and Manufacturing”, Industrial Press, NY, 1967.
3. Kevien Otto and Kristin Wood, Product Design. Pearson Publication, 2004.
4. Product design and development, by K.T. Ulrich and S.D. Eppinger, Tata McGraw Hill.
5. Boothroyd, G, 1980 Design for Assembly Automation and Product Design. New York, Marcel Dekker.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	-	-	-	-
CO2	2	2	-	-	-	-
CO3	3	3	-	-	-	-
CO4	2	2	-	-	-	-
CO5	3	3	-	-	-	-
AVG	3	3	-	-	-	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24RE1101 RESEARCH METHODOLOGY AND IPR L T P C
2 0 0 2

COURSE OBJECTIVES

- To give an overview of the research methodology and explain the technique of defining a research problem.
- To motivate the students towards collecting the article for literature survey.
- To enable the students to gain knowledge of art of writing research reports.

UNIT I RESEARCH DESIGN 6

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys, Research problem formulation, Research gap identification, Formulation of materials and methods.

UNIT II DATA COLLECTION AND SOURCES 6

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying, Advanced tools and techniques.

UNIT III DATA ANALYSIS AND REPORTING 6

Overview of Multivariate analysis, Hypotheses testing and Measures of Association-Presenting Insights and findings using written reports and oral presentation, Computer aided Research – Simulation – Case study.

UNIT IV INTELLECTUAL PROPERTY RIGHTS 6

Intellectual Property - The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Biodiversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT V PATENTS 6

Patents — objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

TOTAL: 30 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Understand the research problem formulation.

CO2: Utilize the data collection techniques for Design of experiments.

CO3: Formulate research proposals, reports and scientific article writing.

CO4: Understand necessity of intellectual property rights.

CO5: Write; file the innovation for obtaining the patent rights.

TEXT BOOKS

1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 2012.
2. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.

REFERENCE BOOKS

1. Ellapu Venkatesh Palagati Anusha, Savuturu Sujith Kumar, Syed Mastan Bashafundamentals of Research Methodology and Intellectual Property Rights, Fedshine Publication, 2023.
2. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.
3. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
4. Kothari, C. R. Research Methodology - Methods and Techniques, New Age International publishers, New Delhi, 2004.
5. Robert P. Merges, Peter S. Menell and Mark A. Lemley, "Intellectual Property in New Technological Age", Aspen Publishers, 2016.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	-	-	2	2
CO2	2	3	-	-	2	2
CO3	3	3	-	-	2	2
CO4	2	3	-	-	2	2
CO5	3	3	-	-	1	2
AVG	3	3	-	-	2	2

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF1201 MANUFACTURING ENGINEERING LABORATORY L T P C
0 0 4 2

COURSE OBJECTIVES

- To learn the basic characteristics of cutting tools, measure tool life.
- To learn principles of surface finish and geometrical accuracy in machining processes.
- To study and practice CNC programs using FANUC codes.

LIST OF EXPERIMENTS

1. Preparation of a single point cutting tool with a given tool geometry.
2. Estimation of chip reduction coefficient and shear angle in orthogonal cutting.
3. Evaluation of the effect of process parameters on cutting forces, surface finish and average cutting temperature in turning process.
4. Measurement of forces, surface roughness and temperature in case of milling and grinding operations.
5. Estimation of tool life of a single point turning tool.
6. Metallurgical evaluation of specimen using metallurgical microscope.
7. Extrusion of cylindrical billets through dies of different included angles and exit diameters and their effect on extrusion pressure.
8. Conduct experiments to improve surface finish of cylindrical workpieces, using centreless grinding process. Comment on the selection of the grinding wheel, finish obtained, obtained geometrical accuracies.
9. Evaluation of the effect of process parameters on MRR and Surface finish in CNC.
10. Specimen preparation and microstructure studies using Optical Microscope and Scanning electron Microscope.
11. Study of IS standards in molding material, sand testing.
12. Write a CNC program (manual) using FANUC codes and machine the component, (production drawing of the part is given). Find out the required machines, cutting tools, cutting parameters and machine the component and measure the dimensions obtained and prepare the measurement chart. Comment on the obtained dimensional tolerances.
13. Study of IS Standard in welding (weld material, weld testing, welding symbol).

TOTAL: 60 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Prepare various cutting tools for surface roughness, milling and grinding operations.
CO2: Assess the impact of process parameters on material removal rate.
CO3: Conduct metallurgical evaluations using microscopes and interpret microstructural changes from various manufacturing processes.
CO4: Apply Indian Standards (IS) in moulding material, sand testing.
CO5: Write and develop CNC programs for producing various components.

CO-PO & PSO Mapping

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	-	-
CO2	3	3	2	2	-	-
CO3	2	2	2	2	-	-
CO4	3	3	3	2	3	-
CO5	3	2	2	2	3	-
AVG	3	2	2	2	3	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF1501 TECHNICAL SEMINAR L T P C
0 0 2 0

COURSE OBJECTIVES

- To enrich the communication skills of the student through presentation of topics in recent advances in engineering/technology.
- To encourage the students to study advanced engineering developments.
- To ensure that students are getting updated with latest technology.

A group of 2 students have to choose a problem and carry out scientific systematic investigation experimentally/ theoretically in suggesting a viable solution. At the end of the semester, each group of students has to submit a report for evaluation.
Depth of understanding, coverage, and quality of presentation material (PPT/OHP) and communication skill of the student will be taken as measures for evaluation.

TOTAL: 30 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Demonstrate a sound technical knowledge of their selected seminar topic.
CO2: Design engineering solutions to complex problems utilizing a systems approach.
CO3: Demonstrate the knowledge, skills and attitudes of a professional engineer.
CO4: Updated with the latest technology in the field of Manufacturing Engineering.
CO5: Summarize and present the technical contents.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	-	-	2	2
CO2	2	-	-	-	2	2
CO3	3	-	-	-	2	2
CO4	2	-	-	-	2	2
CO5	3	-	-	-	1	2
AVG	3	-	-	-	2	2

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF2101 DESIGN AND ANALYSIS OF EXPERIMENTS L T P C
3 0 0 3

COURSE OBJECTIVES

- To attain knowledge in design of equipments.
- To familiarize the multivariable design optimization.
- To learn various optimization techniques to design the product.

UNIT I INTRODUCTION 9

Strategy of Experimentation, Basic Principles, Guidelines for Designing Experiments, A Brief History of Statistical Design, Basic Statistical Concepts, Sampling and Sampling Distributions, Randomized Designs, Hypothesis Testing, Confidence Intervals, Paired Comparison Designs, The Paired Comparison Problem.

UNIT II THE ANALYSIS OF VARIANCE 9

The Analysis of Variance, Analysis of the Fixed Effects Model, Plot of Residuals in Time Sequence, Plot of Residuals Versus Fitted Values, A Regression Model, Contrasts-Orthogonal Contrasts, Scheffé's Method for Comparing All Contrasts, Comparing Pairs of Treatment Means, The Random Effects Model, A Single Random Factor, Analysis of Variance for the Random Model, Estimating the Model Parameters, Least Squares Estimation of the Model Parameters, The General Regression Significance Test, Nonparametric Methods in the Analysis of Variance, the Kruskal–Wallis Test.

UNIT III FACTORIAL DESIGNS 9

Basic Definitions and Principles, The Two-Factor Factorial, Statistical Analysis of the Fixed Effects, Model Adequacy Checking, Estimating the Model Parameters, The General Factorial Design, Fitting Response Curves and Surfaces, Blocking in a Factorial Design. The 2^k Factorial Design.

UNIT IV FITTING REGRESSION 9

Linear Regression Models, Hypothesis Testing in Multiple Regression, Test for Significance of Regression, Tests on Individual Regression Coefficients and Groups of Coefficients, Confidence Intervals in Multiple Regression, Confidence Intervals on the Individual Regression Coefficients, Confidence Interval on the Mean Response, Prediction of New Response Observations, Regression Model Diagnostics.

UNIT V RESPONSE SURFACE METHODS AND DESIGNS 9

Introduction to Response Surface Methodology, the Method of Steepest Ascent, Experimental Designs for Fitting Response Surfaces- Designs for Fitting the First-Order Model, Designs for Fitting the Second-Order Model, Evolutionary Operation, The Two-Factor Factorial with Random Factors, The Two-Factor Mixed Model.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Understand basic requirements of experimental techniques.
CO2: Apply the analysis of variance in design of Experiments.
CO3: Apply the factorial design to obtain response the system.

CO4: Apply the various regression techniques in design of Experiments.
CO5: Apply the response surface method in design.

TEXT BOOKS

1. Montgomery, D.C., "Design and Analysis of Experiments", 5 Ed., John Wiley and Sons Inc., New York, 2006.
2. George. E. P. Box, J. Stuart Hunter, William G. Hunter, "Statistics for Experimenters: Design, Innovation, and Discovery", 2nd Edition, Wiley, 2005.
3. Douglas C. Montgomery, Design and Analysis of Experiments, 10th Edition, 2019.

REFERENCE BOOKS

1. Bell, G.H., J. Ledolter, and A.J. Swersey. March–April, "A Plackett-Burman Experiment to Increase Supermarket Sales of a National Magazine." 2009.
2. Bowerman, B.L., R.T. O'Connell, and E.S. Murphree. Regression Analysis: Unified Concepts, Practical Applications, and Computer Implementation. New York, NY: Business Expert Press, 2015.
3. Hicks, C.R., and K.V. Turner, Jr. Fundamental Concepts in the Design of Experiments. 5th edition. New York, NY: Oxford University Press, 1999.
4. Kilgo, M.B. "An Application of Fractional Factorial Experimental Designs." Quality Engineering 1, pp. 19–23, 1998.
5. Kutner, M.H., C.J. Nachtsheim, J. Neter, and W. Li. Applied Linear Statistical Models. 5th edition. Burr Ridge, IL: McGraw-Hill, 2005.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	-	2	-
CO2	3	3	3	-	2	-
CO3	3	3	3	-	2	-
CO4	3	3	3	-	2	-
CO5	3	3	3	-	2	-
AVG	3	3	3	-	2	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF2102 MATERIALS TESTING AND CHARACTERIZATION TECHNIQUES **L T P C 3 0 0 3**

COURSE OBJECTIVES

- To be proficient in with microscopic techniques to analyze crystal structures.
- To learn the concepts of electron microscopic techniques for characterization.
- To gain the knowledge on various static methods to characterize materials.

UNIT I MICRO AND CRYSTAL STRUCTURE ANALYSIS **9**

Principles of Optical Microscopy – Specimen Preparation Techniques – Polishing and Etching – Polarization Techniques – Quantitative Metallography – Estimation of grain size – ASTM grain size numbers – Microstructure of Engineering Materials - Elements of Crystallography – X- ray Diffraction – Bragg's law – Techniques of X-ray Crystallography – Debye – Scherer camera – Geiger Diffractometer – analysis of Diffraction patterns – Inter planer spacing – Identification of Crystal Structure, Elements of Electron Diffraction.

UNIT II ELECTRON MICROSCOPY **9**

Interaction of Electron Beam with Materials – Transmission Electron Microscopy – Specimen Preparation – Imaging Techniques – BF & DF – SAD – Electron Probe Microanalysis – Scanning Electron Microscopy – Construction & working of SEM – various Imaging Techniques – Applications- Atomic Force Microscopy- Construction & working of AFM – Applications.

UNIT III CHEMICAL AND THERMAL ANALYSIS **9**

Basic Principles, Practice and Applications of X-Ray Spectrometry, Wave Dispersive X-Ray Spectrometry, Auger Spectroscopy, Secondary Ion Mass Spectroscopy, Fourier Transform Infra-Red Spectroscopy (FTIR) - Proton Induced X-Ray Emission Spectroscopy, Differential Thermal Analysis, Differential Scanning Calorimetry (DSC) and Thermo Gravimetric Analysis (TGA).

UNIT IV MECHANICAL TESTING – STATIC TESTS **9**

Hardness – Brinell, Vickers, Rockwell and Micro Hardness Test – Tensile Test – Stress – Strain plot – Proof Stress – Torsion Test - Ductility Measurement – Impact Test – Charpy & Izod – DWTT - Fracture Toughness Test, Codes and standards for testing metallic and composite materials.

UNIT V MECHANICAL TESTING – DYNAMIC TESTS **9**

Fatigue – Low & High Cycle Fatigues – Rotating Beam & Plate Bending HCF tests – S-N curve – LCF tests – Crack Growth studies – Creep Tests – LM parameters – AE Tests-modal analysis - Applications of Dynamic Tests.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Analyze the microstructure and crystal structure of materials using different techniques.

CO2: Study the electron microscopy for various materials using different microscopic techniques.

CO3: Perform the chemical and thermal analysis of the materials using different x-ray and thermal test.

CO4: Analyze the results of static mechanical testing.

CO5: Analyze the results of dynamic mechanical testing.

TEXT BOOKS

1. Culity B.D., Stock S.R& Stock S., Elements of X ray Diffraction, (3rd Edition). Prentice Hall, 2001.
2. ASM Hand book-Materials characterization, Vol – 10, 2004.
3. Davis J. R., Tensile Testing, 2nd Edition, ASM International, 2004.

REFERENCE BOOKS

1. Davis, H.E., Hauck G. & Troxell G.E., The Testing of engineering Materials, (4th Edition), McGraw Hill, College Divn., 1982.
2. Dieter G.E., Mechanical Metallurgy, (3rd Edition), McGraw Hill, 1988.
3. Goldsten,I.J., Dale.E., Echin.N.P.& Joy D.C., Scanning Electron Microscopy & X ray- Micro Analysis, (2nd Edition), Plenum Publishing Corp., 2000.
4. Grundy P.J. and Jones G.A., Electron Microscopy in the Study of Materials, Edward Arnold Limited, 1976.
5. Morita.S, Wiesendanger.R, and Meyer.E, "Non-contact Atomic Force Microscopy" Springer, 2002.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	2	2	-	-
CO2	2	3	2	2	-	-
CO3	2	3	2	2	-	-
CO4	3	3	2	2	-	-
CO5	2	3	3	2	-	-
AVG	2	3	2	2	-	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF2103 MECHANICS OF METAL FORMING L T P C
3 0 0 3

COURSE OBJECTIVES

- To study the basic concepts of metal forming techniques and to develop force calculation in metal forming process.
- To study the thermos-mechanical regimes and its requirements of metal forming.
- To learn the art of processing and making of powder metallurgy components.

UNIT I BEHAVIOUR OF SHEET METAL FORMING PROCESS 9

Uni-axial tension, general sheet forming processes, Yield criteria, Flow rule, Yield criterion and flow rule for Anisotropic material, work of plastic deformation, isotropic and anisotropic yield functions, Bauschinger effect modelling, effective stress and strain. Sheet deformation in plane stress: strain distributions, strain diagram, deformation modes, effective stress-strain laws, principal tensions.

UNIT II FORGING, EXTRUSION AND ROLLING PROCESSES **9**

Metal flow in forging, Analysis of plane strain compression, Analysis of compression of circular disc. Calculation of extrusion load, advances in extrusion, Defects in extrusion. Direct & indirect extrusion. Analysis of longitudinal strip or sheet rolling process (calculation of roll separating force, torque & power, angle of bite, maximum reduction in rolling), rolling defects.

UNIT III WIRE DRAWING AND SHEET FORMING MECHANICS **9**

Wire drawing design and various parameter analysis, load calculation, Flow Rules – Anisotropy - Formability of sheet, Formability tests, forming limit diagrams, strain path diagrams, Case studies. Pressing and Sintering: Workability Studies – Densification.

UNIT IV ADVANCED METAL FORMING TECHNIQUES **9**

High energy rate forming (HERF), hydro forming, super plastic forming, powder metallurgy and forming of composite materials, Forming Process Optimization and CAD/CAM/CAE of Dies.

UNIT V MODELLING AND SIMULATION OF METAL FORMING **9**

Hydro forming, tailor welded blanks, friction stir welding of sheets, incremental sheet forming. The Plane Strain Compression Test, FEM Model and Input Data to the Model - process simulation for deep drawing, Effective Strain and Strain-Rate, Distributions in Deformed Zones. Case studies on the manufacturing aspects of products using the lessons learnt.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Understand the behavior of sheet metal while using the forming process.
CO2: Analyze the different forging, extrusion and rolling processes.
CO3: Analyze the mechanics of wire drawing and sheet forming.
CO4: Apply the various advanced metal forming techniques in metal forming process.
CO5: Analyze the metal forming process using latest software tools.

TEXT BOOKS

1. Modelling Techniques for Metal Forming Processes, G.K. Lal, P.M. Dixit and N.Venkat Reddy, Alpha Science, 2011.
2. Theory of Plasticity, J. Chakrabarty, McGraw Hill, 1998.
3. Basic engineering plasticity, D. W. A. Rees, Elsevier, 2000.

REFERENCE BOOKS

1. Theory of Engineering Plasticity, R. Narayanasamy, R Ponalagusamy, Ahuja Book Company, 2000.
2. Metal Forming: Mechanics and Metallurgy, William F. Hosford, Robert M. Caddell, 2011.
3. Scope Kalpakjian, "Manufacturing processes for Engineering Materials", Addision Wesley, 1997.

4. Metal forming: Processes and Analysis – B. Avitzer-Tata-MGH
5. Mechanical Metallurgy – Dieter-MGH, 1961.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	-	-
CO2	2	3	3	2	-	-
CO3	3	3	3	2	-	-
CO4	3	3	3	2	-	-
CO5	2	3	3	2	3	-
AVG	3	3	3	2	3	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF2104 PRECISION ENGINEERING L T P C
3 0 0 3

COURSE OBJECTIVES

- To learn the knowledge on accuracy and tolerance in machining.
- To develop skills in tolerance analysis principles and datum systems in design.
- To study the tolerance charting techniques.

UNIT I ACCURACY AND ERROR 9

Introduction – Concept of Accuracy of Machine Tools – Spindle and Displacement Accuracies – Accuracy of numerical Control Systems – Errors due to Numerical Interpolation Displacement Measurement System and Velocity lags, Errors due to variation of cutting forces – clamping forces – errors due to compliance while machining. Inaccuracy due to thermal effects: Heat sources and dissipation – Geometry of thermal deformation.

UNIT II TOLERANCING 9

Tolerance Zone Conversions – Surfaces, Features, Features of Size, and Datum Features – Datum Oddly Configured and Curved Surfaces as Datum Features, Equalizing Datums – Datum Feature of Representation – Form controls, Orientation Controls – Logical Approach to Tolerancing.

UNIT III DATUM SYSTEMS 9

Design of freedom, Grouped Datum Systems – different types, two and three mutually perpendicular grouped datum planes; Grouped datum system with spigot and recess, pin and hole; Grouped Datum system with spigot and recess pair and tongue – slot pair – Computation of Transnational and rotational accuracy, Geometric analysis and application.

UNIT IV TOLERANCE ANALYSIS 9

Process Capability, Mean, Variance, Skewness, Kurtosis, Process Capability Metrics, Cp, Cpk, Cost aspects, Feature Tolerances, Geometric Tolerances. Surface finish, Review of relationship between attainable tolerance grades and different machining process, Cumulative effect of tolerances sure fit law, normal law and truncated normal law.

UNIT V TOLERANCE CHARTING TECHNIQUES **9**

Operation Sequence for typical shaft type of components, Preparation of Process drawings for different operations, Tolerance worksheets and centrally analysis, Examples, Design features to facilitate machining; Datum Features – functional and manufacturing Components design – Machining Considerations, Redesign for manufactured, Examples.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Demonstrate a comprehensive understanding of accuracy concepts and the factors affecting machine tool precision.

CO2: Apply tolerancing techniques effectively in the design of components to ensure manufacturability.

CO3: Utilize grouped datum systems to enhance geometric accuracy in component design.

CO4: Conduct tolerance analysis using statistical methods to evaluate process capabilities.

CO5: Prepare tolerance charts and process drawings that effectively communicate manufacturing.

TEXT BOOKS

1. Precision Engineering in Manufacturing/Murthy R.L./New Age International (P) limited, 1996.
2. Geometric Dimensioning and Tolerancing / James D. Meadows / Marcel Dekker inc. 1995.
3. Nano Technology / Norio Taniguchi / Oxford University Press, 1996.

REFERENCE BOOKS

1. Engineering Design – A systematic Approach / Matousek / Blackie & Son Ltd., London, 1963.
2. Precision Engineering/VC Venkatesh & S Izman/TMH, 2007.
3. Basics of Precision Engineering, Richard Leach (Editor), Stuart T. Smith, CRC press, 2018.
4. Murty, R. L., Precision Engineering in Manufacturing, New Age International (P) Limited, New Delhi, 2005.
5. Norio Taniguchi, Nanotechnology, Oxford University Press, New Delhi. 1996.

CO-PO & PSO Mapping

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	-	-	-
CO2	3	2	2	-	-	-
CO3	3	2	2	-	-	-
CO4	3	2	2	-	-	-
CO5	3	2	2	-	-	-
AVG	3	2	2	-	-	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24RE2101 SCIENTIFIC REPORT WRITING L T P C
2 0 0 2

COURSE OBJECTIVES

- To provide the knowledge about various elements of scientific writing, practical experience on text editing.
- To provide basic knowledge to the student's project, proposal and article writing.
- To gain knowledge on proof reading for production of quality of research articles.

UNIT I WRITING SKILL 6

Writing Skills – Essential Grammar and Vocabulary – Passive Voice, Reported Speech, Concord, Signpost words, Cohesive Devices – Paragraph writing - Technical Writing vs. General Writing.

UNIT II PROJECT REPORT 6

Project Report – Definition, Structure, Types of Reports, and Purpose – Intended Audience – Plagiarism– Report Writing in STEM fields – Experiment Statistical Analysis.

UNIT III STRUCTURE OF PROJECT REPORT 6

Structure of the Project Report: Framing a Title – Content – Acknowledgement – Funding Details -Abstract – Introduction – Aim of the Study – Background - Writing the research question -Need of the Study/Project Significance, Relevance – Determining the feasibility – Theoretical Framework.

UNIT IV REPORT WRITING 6

Literature Review, Research Design, Methods of Data Collection - Tools and Procedures - Data Analysis - Interpretation - Findings –Limitations -Recommendations – Conclusion – Bibliography.

UNIT V PROOF READNG 6

Proof reading a report – Avoiding Typographical Errors – Bibliography in required Format – Font –Spacing – Checking Tables and Illustrations – Presenting a Report Orally – Techniques.

TOTAL: 30 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Understand the basic requirements of WRITING SKILL of scientific articles.
CO2: Analyze the all the parameters of the project report for preparation of high-quality project report.
CO3: Analyze the structure of project report.
CO4: Collect suitable literature good scientific writing using the latest tools.
CO5: Produce high quality scientific writing using the proof-reading techniques.

TEXT BOOKS

1. Gerson and Gerson - Technical Communication: Process and Product, 7th Edition, Prentice Hall, 2012.
2. Virendra K. Pamecha - Guide to Project Reports, Project Appraisals and Project Finance, 2012.
3. Daniel Riordan - Technical Report Writing Today, 1998.

REFERENCE BOOKS

1. Darla-Jean Weatherford - Technical Writing for Engineering Professionals, Penwell Publishers, 2016.
2. Sharon J. Gerson, Steven M. Gerson, and Technical Communication: Process and Product by Publisher : Pearson; 9th edition, 2016.
3. Gibaldi, Joseph. MLA handbook for writers of research papers. 7th ed., 2009.
4. Northey, Margot E. Making sense: a student's guide to research, writing & style. 8th ed., 2015.
5. Turabian, Kate L. A manual for writers of term papers theses, and dissertations. 7th ed., 2007.

Mapping of COs and POs

COs	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	2	-	2	-
CO2	2	2	2	-	2	-
CO3	2	2	3	-	2	-
CO4	3	2	2	-	2	-
CO5	2	2	3	-	2	-
AVG	2	2	2	-	2	-

1-Low, 2-Medium, 3-High, '-'-No correlation

24MF2201 METAL FORMING AND SIMULATION LABORATORY L T P C
0 0 4 2

COURSE OBJECTIVES

- To learn about strain hardening and strain rate sensitivity through hands-on experiments.
- To construct and analyze Formability Limit Diagrams (FLDs) and optimize forming processes like water hammer forming and extrusion.
- To use Automation Studio to design and troubleshoot hydraulic, pneumatic, and PLC circuits.

LIST OF EXPERIMENTS

METAL FORMING

1. Determination of strain hardening exponent.
2. Determination of strain rate sensitivity index.
3. Construction of formability limit diagram.
4. Determination of efficiency in water hammer forming.
5. Determination of interface friction factor.
6. Determination of extrusion load.
7. Study on two high rolling process.

SIMULATION

1. Simulation of single and double acting cylinder circuits.
2. Simulation of Hydraulic circuits.
3. Simulation of electro pneumatic circuits.
4. Simulation of PLC circuits.
5. Software simulation of fluid power circuits using Automation studio.

TOTAL: 60 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Determine the various material properties using different testing equipment's.
CO2: Construct Formability Limit Diagrams (FLDs) for assessing material formability.
CO3: Determine the interface friction factor by conducting different experiments.
CO4: Calculate the load required for extrusion processes based on material properties and geometries.
CO5: Create fluid power circuit simulations using software tools.

Mapping of COs and POs

COs	POs					
	PO1	PO2`	PO3	PO4	PO5	PO6
CO1	3	3	-	2	-	-
CO2	3	3	-	3	-	-
CO3	3	3	-	3	-	-
CO4	3	3	-	2	-	-
CO5	3	3	-	3	3	-
AVG	3	3	-	3	3	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF2202 ADVANCED MANUFACTURING PROCESSES LABORATORY **L T P C 0 0 4 2**

COURSE OBJECTIVES

- To learn knowledge on cutting forces and temperature variations during CNC machining processes.
- To acquire knowledge on advanced machining techniques.
- To provide the practical experience in 3D Printing process and robotic programming.

LIST OF EXPERIMENTS

1. Analysis of cutting forces during turning/drilling process in CNC.
2. Analysis of temperature during turning/drilling process in CNC.
3. Study on the effect of process parameters in Electro-Chemical Machining.
4. Study on the effect of process parameters in Electric-Discharge Machining.
5. Transient heat transfer analysis of a rectangular slab using a FEA package.
6. Modelling and simulation of forging/rolling/machining process using a FEA package.
7. Analysis of stress strain distribution in a structural loading of composite bar using MATLAB codes.
8. Design and Manufacturing of product for Rapid Prototyping.
9. Modeling and Analysis of 3D printing.
10. Robotic Verification of transformation (Position and orientation) with respect to gripper and world coordinate system.
11. Robot programming and simulation for pick and place.

TOTAL: 60 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Analyze cutting forces and temperature during CNC turning and drilling processes to assess their impact on machining efficiency.

CO2: Investigate the effects of process parameters on Electro-Chemical Machining (ECM) and Electric-Discharge Machining (EDM) for optimization.

CO3: Conduct heat transfer analysis and simulate forging, rolling, and machining processes using Finite Element Analysis (FEA) techniques.

CO4: Design and manufacture products through rapid prototyping and model 3D printing processes to enhance product development.

CO5: Program and simulate robotic systems for pick-and-place operations and verify transformations in relation to coordinate systems.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	-	2	-	-
CO2	3	3	-	3	-	-
CO3	3	3	-	3	-	-
CO4	3	3	-	2	-	-
CO5	3	3	-	3	3	-
AVG	3	3	-	3	3	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24RE3201 RESEARCH ARTICLE REVIEW L T P C
0 0 4 2

COURSE OBJECTIVES

- To gain knowledge on collecting the research articles.
- To read and understand the various literatures related to the research.
- To write the review article for publication.

STAGES OF REVIEW

Stage 1 Collection of latest Research articles.
Stage 2 Read the entire article and take a note in his/her own words.
Stage 3 Summarize the literature in his/her own words.
Stage 4 Classify and arrange the literatures with template.
Stage 5 Preparation of review article.
Stage 6 Plagiarism checked by the department and it must be less than 10%.
Stage 7 Article must be communicated to the journal.

The students must do the above work individually by the guidance of faculty members and one coordinator is required to monitor the work progress. The evaluation will be done based on the following

a) Review of work after stage 3 10%
b) Review of work after stage 5 20%
c) Review of work after stage 7 20%
d) Final examination 50%

TOTAL: 60 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Understand the technique to collect the literatures from various resources.

CO2: Apply the knowledge for collecting the required research data from the articles.

CO3: Formulate the research problem.

CO4: Analyze the research gap from various researchers work.

CO5: Create the new article to publish in the research journals.

Mapping of COs and Pos

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	-	-	2	-
CO2	2	2	-	-	-	-
CO3	2	2	-	-	-	-
CO4	2	2	-	-	2	-
CO5	2	2	-	-	2	-
AVG	2	2	-	-	2	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF3501 **PROJECT WORK PHASE-I** **L T P C**
0 0 12 6

COURSE OBJECTIVES

- To develop knowledge to formulate a real-world problem.
- To use different tools and techniques to arrive at a solution.
- To prepare a report and give a presentation.

Project Guidelines and Evaluation

- **Selection of a project topic:** It is a crucial and involves a literature survey and creative input, guided by a project supervisor. The topic should allow skill development in design, fabrication, analysis, testing, and research.

- **Literature survey**: Which helps to identify gaps and build on existing research. Initial project work should be completed during Dissertation I to lay the groundwork for further research.
- **Completed project work phase-I:** will be evaluated by internal and external examiners based on an oral presentation and the project report, which is submitted at the end of Dissertation-I. The evaluation follows the institution's credit system regulations.

ESSENTIALS

1. **ZEROTH REVIEW:** Confirmed project title, Print out of base paper, abstract, with minimum of **6 slides** of Power Point Presentation.

2. **FIRST REVIEW:** Reply for queries (if any) given in **ZEROTH REVIEW**, clear

idea about existing and collection of clear literature survey (Minimum of 20 articles) from the reputed journals, with minimum of 15 slides. 25% of work should be completed.

3. **SECOND REVIEW:** Reply for queries (if any) given in **FIRST REVIEW,** collect and prepare the literatures (Minimum of 50 articles) with Literature template, minimum of **30 slides. 50%** of work should be completed.

4. **THIRD REVIEW:** Reply for queries (if any) given in **SECOND REVIEW, 90%** of work completion including Research Gap, Problem statement, Project Workflow Chart, Study of proposed work comparing with existing literatures Example: Calculation, Simulations, Analysis, optimization with minimum of **45 slides.**

TOTAL: 180 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Design and analyze, an identified problem using scientific tools.
CO2: Simulation/ Theoretical analysis of a physical system.
CO3: Integrate various domain knowledge for a sustainable solution.
CO4: Set Goals, Targets, timeline, plan and execute activities of the project.
CO5: Disseminate work both in oral and written format.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	-	-	-
CO2	2	3	2	-	-	-
CO3	3	3	3	-	-	-
CO4	3	3	2	-	-	-
CO5	2	3	3	-	-	-
AVG	3	3	2	-	-	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF4501 PROJECT WORK PHASE-II L T P C
0 0 24 12

COURSE OBJECTIVES

- To define the problem of the proposed research work.
- To enable students to apply any piece of theory and experiments which they have learned to a specific problem related to industry / research.
- To demonstrate and validate the results of the design concept.

ESSENTIALS:

1. ZEROTH REVIEW: Confirmed project title, Print out of base paper, abstract, with minimum of **6 slides** of Power Point Presentation.

2.FIRST REVIEW: Reply for queries (if any) given in **ZEROTH REVIEW**, clear idea about existing and proposed project work, clear literature survey, with minimum of **15 slides**.

3. SECOND REVIEW: Reply for queries (if any) given in **FIRST REVIEW,** nearly **30%** of work completion including Project Workflow Chart, Design, Calculation with minimum of **20 slides.**

4. THIRD REVIEW: Reply for queries (if any) given in **SECOND REVIEW, 50%** of work completion including Project Workflow Chart, Design, Calculation, simulations, Fabrication, with minimum of **25 slides.**

TOTAL: 360 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Identify and formulate research problem.
CO2: Design and develop solution to the problem.
CO3: Analyze and solve the complex problems.
CO4: Plan, implement and execute the project.
CO5: Write effective technical report and demonstrate through presentation.

Mapping of COs and POs

COs	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	3	3	-	-
CO2	2	2	3	3	-	-
CO3	2	2	3	3	-	-
CO4	2	2	3	3	-	-
CO5	2	2	3	3	-	-
AVG	2	2	3	3	-	-

1-Low, 2-Medium, 3-High, '-' - No correlation

24MF2301 MACHINE TOOL DESIGN L T P C
3 0 0 3

COURSE OBJECTIVES

- To develop a comprehensive understanding of the principles and fundamentals of machine tool design and functionality.
- To understand the various types of machine tools and their applications in manufacturing processes.
- To gain design knowledge on guide ways, power screws and spindles.

UNIT I INTRODUCTION TO MACHINE TOOL DESIGN 9

Introduction to Machine Tool Drives and Mechanisms, Auxiliary Motions in Machine Tools, Kinematics of Machine Tools, Motion Transmission.

UNIT II REGULATION OF SPEEDS AND FEEDS **9**

Aim of Speed and Feed Regulation, Stepped Regulation of Speeds, Multiple Speed Motors, Ray Diagrams and Design Considerations, Design of Speed Gear Boxes, Feed Drives, Feed Box Design.

UNIT III DESIGN OF MACHINE TOOL STRUCTURES **9**

Functions of Machine Tool Structures and their Requirements, Design for Strength, Design for Rigidity, Materials for Machine Tool Structures, Machine Tool Constructional Features, Beds and Housings, Columns and Tables, Saddles and Carriage.

UNIT IV DESIGN OF GUIDEWAYS AND POWER SCREWS **9**

Functions and Types of Guideways, Design of Guideways, Design of Aerostatic Slide ways, Design of Anti-Friction Guideways, Combination Guideways, Design of Power Screws.

UNIT V DESIGN OF SPINDLES AND SPINDLE SUPPORT **9**

Functions of Spindles and Requirements, Effect of Machine Tool Compliance on Machining Accuracy, Design of Spindles, Antifriction Bearings. Dynamics of Machine Tools: Machine Tool Elastic System, Static and Dynamic Stiffness.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Apply fundamental principles of machine tool design for efficient and effective tooling solutions for various manufacturing applications.

CO2: Analyze the performance characteristics of different types of machine tools for specific machining processes.

CO3: Understand the design considerations related to material selection, mechanical properties, and manufacturing processes in machine tool design.

CO4: Design the guide ways and power crews.

CO5: Design the guide spindles and it supports.

TEXT BOOKS

1. N.K. Mehta, Machine Tool Design and Numerical Control, TMH, New Delhi, 3rd edition 2012
2. G.C. Sen and A. Bhattacharya, Principles of Machine Tools, New Central Book Agency, 2015
3. K Pal, S. K. Basu, “Design of Machine Tools”, 6th Edition. Oxford IBH, 2014

REFERENCE BOOKS

1. N. S. Acherkhan, “Machine Tool Design”, Volume 2 University Press of the Pacific, 2000.
2. F. Koenigsberger, Design Principles of Metal-Cutting Machine Tools, Pergamon Press, 1964.
3. F. Koenigsberger, Machine Tool Structures, Pergamon Press, 1970.

4. N Mehta, Machine Tools Design and Numerical Control, 3rd Edition, 2017.
5. Acherkan, "Machine Tool Design", Vol 2 & 3, MIR Pub, Russia, 1968.

Mapping of COs and Pos

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	-	-	-
CO2	2	3	2	-	-	-
CO3	3	3	3	-	-	-
CO4	3	3	2	-	-	-
CO5	3	2	3	-	-	-
AVG	3	3	3	-	-	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF2302 PLASTICITY AND METAL FORMING L T P C
3 0 0 3

COURSE OBJECTIVES

- To understand the elastic and plastic behavior of metals.
- To learn the mechanics and classification of metal forming processes.
- To develop problem-solving skills for analyzing forces, stresses, and defects in metal working.

UNIT I BRIEF REVIEW OF ELASTIC AND PLASTIC BEHAVIOR OF METALS 9

Continuous, homogeneous and isotropic bodies, Concept of stress and strain, types of stresses and strains, description of stress at a point, plane stress, state of stress in three dimensions, Principal Stresses, Description of strain at a point, hydrostatic and deviator components of stress and strain energy. Flow curves for different materials, true stress and strain, yield criteria for ductile metals – Von mise criterion, Tresca criterion, yield locus, anisotropy in yielding, yield surface, octahedral sheer stress and shear strain, invariants of stress and strain, plastic stress-strain relations, Levy-Mises equations for ideal plastic solid, problems on yield criteria and true stress and strain.

UNIT II FUNDAMENTALS OF METAL WORKING 9

Classification of forming processes, Hot working, Cold Working, Warm Working, Mechanics of Metal Working, flow stress determination - plain strain compression test, Temperature in metal working, Strain-rate effects, Metallurgical Structure, lubrication-sticking and sliding friction, Deformation hydrostatic pressure, Workability limit diagram and residual stresses.

UNIT III FORGING 9

Forging: Classification, forging equipment, determination of compressive stress for plate and disc, open and closed die forging, residual stresses in forgings, forging defects and problems.

UNIT IV ROLLING OF METALS **9**

Rolling of metals: Classification of Rolling mills, forces and geometrical relationships in rolling, simplified analysis of rolling load, theories of cold and hot rolling, roll separating force, Power loss in bearings, torque and power, front and back tensions, defects in rolled products and problems.

UNIT V EXTRUSION & DRAWING **9**

Extrusion: Classification, extrusion equipment, Process variables, Analysis of extrusion processes, tube extrusion, production of seamless pipe and tubing, extrusion defects and problems. Drawing: Analysis of wire drawing, Rod and wire drawing, dies in drawing, tube drawing, analysis of tube drawing, Residual stresses, redundant work and estimation, optimal cone angle and dead zone formation, defects and problems.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Analyze the elastic and plastic behavior of metals, including stress-strain relationships and yield criteria.

CO2: Analyze metalworking processes, considering flow stress, strain-rate, and temperature effects.

CO3: Calculate forces and stresses in forging to reduce common defects and residual stresses.

CO4: Analyze rolling operations, including load, torque, and tension, and identify product defects.

CO5: Evaluate extrusion and drawing processes parameters and defects.

TEXT BOOKS

1. Mechanical Metallurgy - Dieter G.E. - Mc Graw Hill Publications, 1961.
2. Metals Handbook – ASM - Volume II – ASM, 1979.
3. Fundamentals of working of Metals - Sach G. - Pergamon Press. 1968.

REFERENCE BOOKS

1. Materials Science and Engineering: An Introduction - William D. Callister, Jr, David G. Rethwisch – Wiley Publication. 2009.
2. Fundamentals of Metal Forming Processes by B.L. Juneja, 2018.
3. Continuum Theory of Plasticity by A.S. Khan and S. Huang, John Wiley and Sons Inc., 1995.
4. Theory of Plasticity by J. Chakrabarty, McGraw-Hill Book Co., International Edition, 1987.
5. Advanced Mechanics of solids L. S. Srinath Tata Mc. Graw Hill 2009.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	-	-	-
CO2	3	2	2	-	-	-
CO3	2	3	2	-	-	-
CO4	3	3	2	-	-	-
CO5	3	3	2	-	-	-
AVG	3	3	2	-	-	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF2303 PRODUCT DESIGN AND DEVELOPMENT L T P C
3 0 0 3

COURSE OBJECTIVES

- To familiarize students with the stages of product development, including concept generation and specification.
- To integrate Industrial Design processes and cost reduction in manufacturing.
- To develop Prototyping Skills and techniques and economic analysis for effective project management.

UNIT I PRODUCT DEVELOPMENT AND CONCEPT SELECTION 9

Product development process – Product development organizations- Identifying the customer needs – Establishing the product specifications – concept generation – Concept selection.

UNIT II PRODUCT ARCHITECTURE 9

Product architecture – Implication of the architecture – Establishing the architecture – Related system level design issues.

UNIT III INDUSTRIAL AND MANUFACTURING DESIGN 9

Need for industrial design – Impact of industrial design – Industrial design process. Assessing the quality of industrial design- Human Engineering consideration - Estimate the manufacturing cost – Reduce the component cost – Reduce the assembly cost – Reduce the support cost – Impact of DFM decisions on other factors.

UNIT IV PROTOTYPING AND ECONOMIC ANALYSIS 9

Principles of prototyping – Planning for prototypes - Elements of economic analysis – Base case financial model – Sensitivity analysis – Influence of the quantitative factors.

UNIT V MANAGING PRODUCT DEVELOPMENT PROJECTS 9

Sequential, parallel and coupled tasks - Baseline project planning – Project Budget Project execution – Project evaluation- patents- patent search-patent laws international code for patents.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Explain the stages of the product development process, including customer needs identification.

CO2: Analyze and establish product architecture and system-level design issues.

CO3: Apply industrial design principles to enhance product quality and optimize costs.

CO4: Plan prototyping and perform economic analyses using financial models.

CO5: Manage product development projects, including budgeting and understanding patent laws.

TEXT BOOKS

1. Charles Gevirtz, Developing New products with TQM, McGraw – Hill International editions, 1994.
2. Karal .T. Ulrich, Steven D.Eppinger, Product Design and Development, Mc GRAW-HILL International Editions.2003.
3. S. Rosenthal, Effective product design and development, Irwin 1992.

REFERENCE BOOKS

1. Ming Wang Fu, Design and Development of Metal-forming Processes and Products Aided by Finite Element Simulation, 2018.
2. Ulrich, Karl, and Steven Eppinger. Product Design and Development. 3rd ed. New York, NY: McGraw-Hill, 2003.
3. Thomke, Stefan, and Ashok Nimgade. "IDEO Product Development." Boston, MA: Harvard Business School Case 9-600-143, June 22, 2000.
4. Bowen, H. Kent, and Thomas Everett. "SweetWater." Boston, MA: Harvard Business School Case 9-695-026, November 1, 1994.
5. Chitale, A K, Product Design & Manufacturing, 6th Edition, PHI publication, India, 2013.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	-	-	-
CO2	3	2	2	-	-	-
CO3	3	3	2	-	-	-
CO4	2	2	2	-	2	-
CO5	2	2	3	-	2	-
AVG	3	2	2	-	2	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF2304 **SURFACE ENGINEERING** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- Equip students with a comprehensive understanding of surface engineering principles, including the significance of surface properties and energy in engineering applications.
- Provide knowledge on various thin film deposition techniques, their mechanisms, and their applications in modern engineering and technology.
- Enable students to evaluate different characterization techniques for assessing surface properties, including mechanical, physical, and chemical characteristics.

UNIT I INTRODUCTION TO SURFACE ENGINEERING **9**

Introduction- Significance of surface engineering- Solid surface- Surface energy superficial layer- Physic-chemical parameters- Properties of the superficial layer Surface coating- Classification.

UNIT II THIN FILM DEPOSITION TECHNIQUES **9**

Physical vapor deposition (PVD): Ion plating- Sputter deposition- Reactive deposition- Magnetron sputtering- Chemical vapor deposition (CVD) - Ion implantation- Electron beam technology- Applications.

UNIT III THERMAL SPRAY COATING TECHNOLOGIES **9**

Thermal Spraying Techniques- Flame Spraying, Atmospheric Plasma Spraying (APS), Vacuum Plasma Spraying (VPS), Detonation-Gun Spraying (D-GUN), High-Velocity OxyFuel (HVOF) Spraying-Applications.

UNIT IV LASER SURFACE ENGINEERING **9**

Laser surface engineering- Laser transformation hardening - Laser remelting- Laser alloying- Laser cladding- Laser ablation- Pulsed laser deposition- Laser doping - Laser crystallization- Laser surface texturing- Laser shock peening.

UNIT V CHARACTERIZATION METHODS FOR SURFACE ANALYSIS **9**

Methods of characterization-Microstructure- Mechanical: Adhesion-Hardness-micro hardness- Residual Stress-Friction-Wear- Physical: Porosity-Density- Electrical: Conductivity- Magnetic- Chemical.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Explain the fundamental concepts and significance of surface engineering in enhancing material performance.

CO2: Demonstrate the various thin film deposition techniques, identifying their advantages and specific applications.

CO3: Select the appropriate thermal spraying techniques based on material

requirements and application contexts.

CO4: Understand the laser surface engineering techniques.

CO5: Evaluate the mechanical, physical, and chemical properties of surfaces.

TEXT BOOKS

1. Tadeusz Burakowski, Tadeusz Wierzchon, “Surface Engineering of Metals Principles, equipment and technologies”, CRC Press, 1999.
2. Lech Pawlowski, "The Science and Engineering of Thermal Spray Coatings", 2nd Edition, John Wiley & Sons, 2008.
3. William M. Steen, Jyotirmoy Mazumder, “Laser Material Processing”, 4th Edition, Springer Verlag, 2010.

REFERENCE BOOKS

1. Surface Engineering by Dr. Aniket Bhanudas Kolekar, Publisher: Tech Knowledge Publications, 2023.
2. Ramnarayan chattopadhyay, advanced thermally assisted surface engineering processes, kluwer academic publishers, 2004.
3. Varghese C D, Electroplating and other surface treatments – a practical guide, TMH, 1993.
4. Adamson A W and Gast A P, Physical chemistry of surfaces, 6th Ed., John Willey & Sons 1997.
5. Sudarshan T S, Surface modification technologies – an engineer’s guide; Marcel Dekkar, Newyork, 1989.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	-	-	-
CO2	2	2	2	-	-	-
CO3	3	2	3	-	-	-
CO4	3	2	2	-	-	-
CO5	3	2	3	-	-	-
AVG	3	2	2	-	-	-

1-Low, 2-Medium, 3-High, ‘-’- No correlation

24MF2305 TRIBOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES

- Equip students with a comprehensive understanding of tribology principles, including friction, wear, and lubrication, and their significance in industrial applications.
- Enable students to analyse the physical and chemical characteristics of solid surfaces, including surface roughness, and their effects on tribological behaviour.

- Introduce students to micro/Nano tribology and advanced measurement techniques, preparing them for research and development in cutting-edge tribological applications.

UNIT I INTRODUCTION TO TRIBOLOGY **9**

Industrial significance of tribology - Strength and deformation properties of solids – physiochemical characteristics of solid surfaces –fracture-modes of fracture- ductile and brittle-Analysis of surface roughness - measurement.

UNIT II FUNDAMENTALS AND ANALYSIS OF FRICTION **9**

Friction - classification - Adhesion theory of friction - Elastic, plastic and visco - elastic effects in friction - rolling friction - friction of materials - alloys - ceramics - polymers - Interface temperature of sliding surfaces - measurement.

UNIT III WEAR MECHANISMS AND TYPES **9**

Wear - forms of wear-abrasive wear – adhesive wear - erosive wear -cavitation wear corrosive wear-oxidative wear- fatigue wear - melting wear - diffusive wear – mechanisms - wear of nonmetallic materials.

UNIT IV LUBRICATION TYPES AND ANALYSIS **9**

Lubrication –types of lubrication-hydro dynamic lubrication - Reynolds equation – hydrostatic lubrication - bearing analysis – elastic hydro dynamic lubrication - solid lubrication – boundary lubrication.

UNIT V MICRO / NANO TRIBOLOGY AND MEASUREMENT TECHNIQUES **9**

Micro/nano tribology - Measurement techniques - Surface Force Apparatus (SFA) - Scanning Probe Microscopy - Atomic Force Microscopy (AFM)-Nano-mechanical Properties of Solid Surfaces and Thin Films - Computer Simulations of Nanometer-Scale Indentation and Friction.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Articulate the key concepts and terminology related to tribology, including types of friction and wear mechanisms.

CO2: Demonstrate the ability to analyse and measure surface roughness and other physiochemical properties of solid surfaces.

CO3: Identify different wear mechanisms and assessing their implications in various materials.

CO4: Analyze different types of lubrication methods, including hydrostatic and hydrodynamic lubrication, and apply relevant equations in engineering scenarios.

CO5: Proficient in modern measurement techniques used in micro/Nano tribology.

TEXT BOOKS

1. M. Hutchings, “Tribology: Friction and Wear of Engineering Materials”, Elsevier

Limited, 1992.
2. G. W. Stachowiak, A. W. Batchelor, "Engineering Tribology", Elsevier Limited, 2005.
3. K.C. Ludema, "Friction, wear, lubrication: A text book in tribology", CRC Press, 1996.

REFERENCE BOOKS

1. Bharat Bhushan, "Principles and applications of tribology", John Wiley & Sons, 1999.
2. Bharat Bhushan, "Nanotribology and Nano mechanics: An Introduction", Springer, 2008.
3. Rabinowicz.E., "Friction and Wear of materials", John Willey &Sons,1995.
4. Joseph R. Davis, Corrosion: Understanding the Basics, ASM International, 2000.
5. Harish Hirani, Fundamentals of Engineering Tribology with Applications, 2016.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	-	-	-
CO2	2	2	2	-	-	-
CO3	3	2	3	-	-	-
CO4	3	2	2	-	-	-
CO5	3	2	3	-	-	-
AVG	3	2	2	-	-	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF2306 ROBOT DESIGN AND PROGRAMMING L T P C
3 0 0 3

COURSE OBJECTIVES

- Equip students with definitions, classifications, specifications, configurations, work volumes, control systems, and degrees of freedom.
- Enable students to analyze robotic systems using kinematic and dynamic principles, including forward/inverse kinematics and trajectory planning.
- To educate the students to design, program, and integrate sensors and actuators in robotic systems using AI and programming methodologies.

UNIT I INTRODUCTION 9

Definition, Need Application, Types of robots – Classifications – Configuration, work volume, control loops, controls and intelligence, specifications of robot, degrees of freedoms, end effectors – types, selection applications.

UNIT II ROBOT KINEMATICS 9

Introduction – Matrix representation Homogeneous transformation, forward and inverse – Kinematic equations, Denvit – Hartenbers representations – Inverse Kinematic relations.

Fundamental problems with D-H representation, differential motion and velocity of frames – Jacobian, Differential Charges between frames.

UNIT III ROBOT DYNAMICS AND TRAJECTORY PLANNING 9

Lagrangeon mechanics, dynamic equations for sing, double and multiple DOF robots – static force analysis of robots, Trajectory planning – joint space, Cartesian space description and trajectory planning – third order, fifth order - Polynomial trajectory planning, Machine Vision.

UNIT IV ROBOT PROGRAMMING & AI TECHNIQUES 9

Types of Programming – Teach Pendant programming – Basic concepts in A1 techniques – Concept of knowledge representations – Expert system and its components.

UNIT V ROBOT SENSORS AND ACTUATOR 9

Design of Robots – characteristics of actuating systems, comparison, microprocessors control of electric motors, magneto strictive actuators, shape memory type metals, sensors, position, velocity, force, temperature, pressure sensors – Contact and non-contact sensors, infrared sensors, RCC, vision sensors.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Classify robots and their industry applications, demonstrating an understanding of specifications and capabilities.
CO2: Derive kinematic equations, utilizing Denavit-Hartenberg parameters.
CO3: Formulate dynamic equations for robots and perform static force analysis.
CO4: Develop and implement trajectory planning algorithms for smooth motion.
CO5: Select and integrate sensors and actuators for enhanced robotic functionality.

TEXT BOOKS

1. Gordon Mair, 'Industrial Robotics', Prentice Hall (U.K.) 1988.
2. Groover.M.P. Industrial Robotics, McGraw – Hill International edition, 1996.
3. Saeed.B. Niku, 'Introduction to Robotics, Analysis, system, Applications', Pearson educations, 2002.

REFERENCE BOOKS

1. Craig, John J., Introduction to Robotics: Mechanics and Control, Pearson Education, 2018.
2. Siciliano, Bruno, and Oussama Khatib (Eds.), Springer Handbook of Robotics, Springer, 2016.
3. Kolling, Andreas, and Seth Hutchinson, Multi-Robot Systems: From Swarms to Intelligent Automata, Springer, 2020.
4. Wesley E Snyder R, 'Industrial Robots, Computer Interfacing and Control', Prentice Hall International Edition, 1988.
5. Morgan Quigley, Brian Gerkey, Programming Robots with ROS, 2016.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	-	2	-
CO2	3	3	3	-	2	-
CO3	3	3	3	-	2	-
CO4	3	3	3	-	2	-
CO5	3	3	3	-	2	-
AVG	3	3	3	-	2	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF2307 MICRO AND NANO MANUFACTURING PROCESS L T P C
3 0 0 3

COURSE OBJECTIVES

- Provide a comprehensive overview of mechanical and beam energy-based micro machining methods, focusing on principles and applications.
- Equip students with skills to use advanced techniques for analyzing micro and nano materials, assessing their properties and performance.
- Familiarize students with nanomaterial synthesis methods and processing techniques, highlighting recent trends in micro machining and nanotechnology.

UNIT I MECHANICAL MICRO MACHINING 9

Mechanical Micro machining – Ultra Sonic Micro Machining – Abrasive Jet Micro Machining – Water Jet Micro Machining – Abrasive Water Jet Micro Machining – Micro turning – Chemical and Electro Chemical Micro Machining – Electric discharge micro machining.

UNIT II BEAM ENERGY BASED MICRO MACHINING 9

Electron Beam Micro Machining – Laser Beam Micro Machining – Electric Discharge Micro Machining – Ion Beam Micro Machining –Plasma Beam Micro Machining – Hybrid Micro machining – Electro Discharge Grinding – Electro Chemical spark micro machining – Electrolytic in process Dressing.

UNIT III STRUCTURAL CHARACTERIZATION 9

X-ray diffraction, small angle X-ray Scattering, Optical Microscope and their description, Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM), TEM and EDAX analysis, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM).

UNIT IV NANO-MATERIALS SYNTHESIS AND PROCESSING 9

Methods for creating Nanostructures; Processes for producing ultrafine powders- Mechanical grinding; Wet Chemical Synthesis of nano-materials- sol-gel process, Liquid solid reactions; Gas Phase synthesis of nano-materials- Furnace, Flame assisted ultrasonic spray pyrolysis; Gas Condensation Processing (GPC), Chemical Vapour Condensation (CVC)- Cold Plasma Methods, Laser ablation, Vapour – liquid –solid growth, particle precipitation aided CVD, summary of Gas Condensation Processing (GPC).

UNIT V RECENT TRENDS AND APPLICATIONS **9**

Metrology for micro machined components – Ductile regime machining– AE based tool wear compensation– Machining of Micro gear, micro nozzle, micro pins – Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Understand various micro machining methods, selecting appropriate techniques for specific challenges.

CO2: Proficient to use structural characterization techniques (e.g., SEM, TEM, XRD) to analyze micro and nano materials.

CO3: Synthesize the nanostructures using wet chemical and gas phase methods.

CO4: Develop the solutions for machining challenges by integrating advanced technologies.

CO5: Apply metrology principles for evaluating micro machined components, ensuring quality and precision.

TEXT BOOKS

1. Bandyopadhyay. A.K., Nano Materials, New age international publishers, New Delhi, 2008.
2. Bharat Bhushan, Handbook of nanotechnology, springer, Germany, 2010.
3. Jain V.K., 'Introduction to Micro machining' Narosa Publishing House, 2011.

REFERENCE BOOKS

1. Jain V.K., Advanced Machining Processes, Allied Publishers, Delhi, 2002.
2. Jain V. K., Micro Manufacturing Processes, CRC Press, Taylor & Francis Group, 2012.
3. Giovanni Lucchetta, Advances in Micro and Nano Manufacturing, Publisher: Mdpi AG, 2022.
4. V. K. Jain, Introduction to Micromachining, (Ed.), Narosa publisher, 2010.
5. Mark J. Jackson, Microfabrication & Nano manufacturing, CRC press, 2005.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	-	-	-
CO2	3	3	3	-	-	-
CO3	3	3	3	-	-	-
CO4	3	3	3	-	-	-
CO5	3	3	3	-	-	-
AVG	3	3	3	-	-	-

1-Low, 2-Medium, 3-High, '-'- no correlation

24MF2308 ADVANCED JOINING TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES

- Equip students with knowledge of computational tools and models for analyzing welding heat transfer, stresses, and microstructure in welded joints.
- Familiarize students with radiant energy welding techniques, specifically electron beam and laser beam welding, including their principles, equipment, and applications.
- Introduce students to micro joining and nano joining processes, emphasizing methods, applications, and the challenges associated with joining at small scales.

UNIT I COMPUTATIONAL WELDING MECHANICS 9

The Computing Environment, Computational Geometry, Models for Welding Heat Sources, Kinematic Models for Welding Heat Transfer, Evaluation of the Double Ellipsoid Model, Modeling Thermal Stresses and Distortions in Welds, Microstructure Modeling in Heat Affected Zone (HAZ)- Input Data for Computational Welding Mechanics.

UNIT II ADVANCED WELDING PROCESSES 9

Radiant energy welding: Electron Beam Welding-Background of the Process, Guns, Weld Environment, Welding in Different Degrees of Vacuum, Equipment and Safety, Joint Design, Applications, Laser Beam Welding, Physics of Lasers, Types of Lasers, Process Parameters, Applications and Limitations.

UNIT III MICROJOINING AND NANOJOINING PROCESSES 9

Microelectronics wire bonding, Solid-state diffusion bonding, Bonding using nanoparticles, Diffusion soldering and brazing, Laser soldering, Flux less soldering, Laser micro welding, Adhesive bonding, Electron beam micro welding, Introduction to Nano joining.

UNIT IV MICRO JOINING OF MATERIALS AND ITS APPLICATIONS 9

Joining of high temperature superconductors, joining of shape memory alloys, Wafer bonding, Plastics micro welding, Micro joining in medical components and devices, Hermetic sealing of solid oxide fuel cells, Joining of bulk nanostructured materials, Ceramic/metal bonding.

UNIT V JOINING OF NON-FERROUS METALS 9

Welding of Cu, Al, Ti and Ni alloys: processes, difficulties, microstructures, defects and remedial measures. Process induced defects: significance, remedial measures, hot cracking, cold cracking, and lamellar tearing, reheat cracking. Weldability tests, effect of metallurgical parameters. Computational Study through software packages.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Apply computational models for analyze welding processes and predict thermal stresses and distortions.

CO2: Understand the principles and applications of advanced welding processes, including electron beam and laser welding.

CO3: Demonstrate proficiency in various micro joining and nano joining methods, evaluating their suitability for specific applications.

CO4: Identify the appropriate joining techniques for advanced materials, including high temperature superconductors and shape memory alloys.

CO5: Analyze the process-induced defects in non-ferrous metals, understanding their causes and remedial measures through computational studies.

TEXT BOOKS

1. R. S. Parmer, Welding Engineering and Technology, Khanna Publishers, 1997.
2. B. Cary Howard, Modern Welding Technology, Prentice Hall, 1998.
3. G.E. Linnert, Welding Metallurgy, 4th ed., Vol. I and II, AWS, 1994.

REFERENCE BOOKS

1. H. Granjon, Fundamentals of Welding Metallurgy, Jaico Publishing House, 1994.
2. Computational Welding Mechanics, John A. Goldak and Mehdi Akhlaghi, springer, 2005.
3. Micro joining and Nano joining, A volume in Woodhead Publishing Series in Welding and Other Joining Technologies Book, 2008.
4. Advanced Joining Processes by Lucas F. M. da Silva , Mohamad S. El-Zein , Paulo A. F. Martins, Publisher : Springer, 2020.
5. L-E Lindgren: Computational welding mechanics, Woodhead Publishing Limited, 2007.

Mapping of COs and POs

COs	POs					
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CO2	3	3	3	-	2	-
CO3	3	3	3	-	2	-
CO4	3	3	3	-	2	-
CO5	3	3	3	-	2	-
AVG	3	3	3	-	2	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF2309 THEORY OF ELASTICITY AND PLASTICITY L T P C
3 0 0 3

COURSE OBJECTIVES

- Study the mathematical formulation of elasticity theory, including equilibrium equations, compatibility conditions, and boundary conditions.

- Apply analytical methods to solve basic elasticity problems such as beam bending, torsion of shafts, and stress concentration in various structures.
- Analyze metal forming processes such as rolling, forging, and extrusion using plasticity theory.

UNIT I FUNDAMENTALS OF ELASTICITY **9**

Two-dimensional stress analysis - Plane stress - Plane strain - Equations of compatibility - Stress function - Boundary conditions, Problem In Rectangular Coordinates- Solution by polynomials - Saint Venent's principles - Determination of displacement - Simple beam problems, Problems In Polar Coordinates- General equations in polar coordinates – Stress Distribution symmetrical about axis - Strain components in polar coordinates - Simple and symmetric problems.

UNIT II THREE-DIMENSIONAL ANALYSIS OF STRESS AND STRAIN **9**

Differential equations of equilibrium and compatibility - Displacement - Uniqueness of solution - Reciprocal theorem Principle stresses – Homogeneous deformations - Strain spherical and deviatoric stress - Hydrostatic strain.

UNIT III BENDING OF PRISMATIC BARS **9**

Stress function - Bending of cantilever beam - Beam of rectangular cross- section - Beams of circular cross-section.

UNIT IV PLASTICITY **9**

Plastic deformation of metals - Structure of metals - Deformation - Creep stress relaxation of deformation - Strain rate condition of constant maximum shear stress - Condition of constant strain energy - Approximate equation of plasticity.

UNIT V METHODS OF SOLVING PRACTICAL PROBLEMS **9**

The characteristic method - Engineering method -Compression of metal under press - Theoretical and experimental data drawing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Understand the fundamentals of elasticity.
CO2: Apply three-dimensional analysis on stress and strain.
CO3: Apply bending of prismatic bars on stress function.
CO4: Create simple approximate methods using variational formulations.
CO5: Understanding advanced literature on plasticity theory will be made possible by an introduction to plasticity.

TEXT BOOKS

1. An Engineering Theory of Plasticity/E.P. Unksov/Butterworths, 1987
2. Theory of Plasticity for Engineers/Hoffman and Sacks/TMH, 1989.
3. Theory of Elasticity and Plasticity, PHI Learning, H. Jane Helena, 2017.

REFERENCE BOOKS

1. Theory of Elasticity/Timoshenko S.P. and Goodier J.N./Koakusha Publishers, 1951.
2. Theory of Elasticity and Plasticity/Sadhu Singh/ Khanna Publishers.
3. Theory of Elasticity and Plasticity, PHI Learning, H. Jane Helena, 2017.
4. "Elasticity: Theory, Applications, and Numerical Simulations" by S. K. Gupta published by Springer, 2010.
5. "Theory of Elasticity" S. S. Rattan Oxford University Press.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	-	-	-
CO2	2	3	2	-	-	-
CO3	2	3	3	-	-	-
CO4	3	3	2	-	-	-
CO5	2	3	2	-	-	-
AVG	2	3	2	-	-	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF2310 MATERIALS TECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES

- Establish a framework for the classification of materials such as metals, polymers, ceramics, and composites and their attributes.
- Analyze how materials respond to various loads and conditions, including tension, compression, shear, and torsion.
- Study the unique properties and uses of these materials in industries such as aerospace, automotive, electronics, and healthcare.

UNIT I MODERN MATERIALS 9

Dual Steels, Micro alloyed, High Strength Low alloy (HSLA) Steel, Transformation induced plasticity (TRIP) Steel, Maraging Steel, Inter metallics, Ni and Ti Aluminides, Smart Materials, Shape Memory alloys, Metallic Glass Quasi Crystal and Nano Crystalline Materials. Polymeric materials and their molecular structures, Production Techniques for Fibers, Foams, Adhesives and Coatings, structure, Properties and Applications of Engineering Polymers, Advanced Structural Ceramics WC, TiC, TaC, A12 O3, SiC, Si3 N4, CBN and Diamond – properties, Processing and applications.

UNIT II ELASTICITY AND PLASTICITY 9

Elasticity in metals and polymers, mechanism of plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals, strengthening mechanism, work hardening, solid solution, grain boundary strengthening. Poly phase mixture, precipitation, particle, fiber and dispersion strengthening, effect of temperature, strain and strain rate on plastic behavior, super plasticity, deformation of non-crystalline material.

UNIT III FRACTURE ANALYSIS **9**

Griffth's Theory, stress intensity factor and fracture Toughness, Toughening Mechanisms, Ductile and Brittle transition in steel, High Temperature fracture, Creep, Larson – Miller parameter, Deformation and Fracture mechanism maps.

UNIT IV FATIGUE ANALYSIS **9**

Fatigue, Low and High cycle fatigue test, Crack Initiation and Propagation mechanism and paris Law, Effect of surface and metallurgical parameters on Fatigue, Fracture of non-metallic materials, fatigue analysis, Sources of failure, procedure of failure analysis.

UNIT V SELECTION OF MATERIALS **9**

Motivation for selection, cost basis and service requirements, Selection for Mechanical Properties, Strength, Toughness, Fatigue and Creep. Selection for Surface durability, Corrosion and Wear resistance, Relationship between Materials Selection and Processing, Case studies in Materials Selection with relevance to Aero, Auto, Marine, Machinery.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Understand the fundamentals of material science to comprehend how bonding and atomic structure impact material behavior.

CO2: Analyze the stress-strain data to calculate essential mechanical parameters such modulus of elasticity, yield strength, toughness, hardness, and fatigue resistance.

CO3: Recognize and design against material failure mechanisms like creep, fatigue, and fracture.

CO4: Analyze different processing techniques affect the microstructure and characteristics of materials.

CO5: Determine the possible applications of special materials in the electronics, automotive, aerospace, and healthcare sectors.

TEXT BOOKS

1. Selection and use of Engineering Materials 3e/Charles J.A/Butterworth Heiremann, 1999.
2. Mechanical Behavior of Materials/Thomas H. Courtney/ McGraw Hill/2 nd Edition/2000.
3. Mechanical Metallurgy/George E. Dicter/McGraw Hill, 1998.

REFERENCE BOOKS

1. Material Science and Engineering/William D Callister/ Wiley India Pvt Ltd /2014.
2. Fundamentals of Materials Science and Engineering: An Integrated Approach" Author: William D. Callister Jr. and David G. Rethwisch, Publication Year: (5th Edition), 2018.
3. Materials Science and Engineering: A First Course" V. Raghavan 2015 published by PHI Learning.

4. Materials Science and Engineering: An Introduction" Author: Charles M. G. (C. M. G.) K. (K. K.)Publication Year: 2019 published by Wiley.
5. Principles of Materials Science and Engineering" Author: John P. Bentz Publication Year: 2009.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	-	2	-
CO2	3	3	3	-	2	-
CO3	3	3	3	-	2	-
CO4	3	3	3	-	2	-
CO5	3	3	3	-	2	-
AVG	3	3	3	-	**2**	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF2311 ADVANCED CASTING AND WELDING TECHNOLOGIES **L T P C 3 0 0 3**

COURSE OBJECTIVES

- Equip students with fundamental principles of casting design, focusing on heat transfer, solidification, and the design of gating and riser systems.
- Provide insights into the solidification processes of various metals and alloys, including their castability, defects, and techniques to improve casting quality.
- Familiarize students with welding metallurgy principles, weldability of different materials, and advanced welding techniques, along with their applications in various industries.

UNIT I CASTING DESIGN **9**

Heat transfer between metal and mould — Design considerations in casting – Designing for directional solidification and minimum stresses - principles and design of gating and riser-Melting and casting quality.

UNIT II CASTING METALLURGY **9**

Solidification of pure metal and alloys – shrinkage in cast metals – progressive and directional solidification – Degasification of the melt-casting defects – Castability of steel, Cast Iron, Al alloys, Babbitt alloy and Cu alloy.

UNIT III RECENT TRENDS IN CASTING AND FOUNDRY LAYOUT **9**

Shell molding, precision investment casting, CO_2 molding, centrifugal casting, die casting, Continuous casting, Counter gravity low pressure casting, Squeeze casting and semisolid processes. Layout of mechanized foundry – sand reclamation – material handling in foundry pollution control in foundry — Computer aided design of casting.

UNIT IV WELDING METALLURGY AND DESIGN **9**

Heat affected Zone and its characteristics – Weldability of steels, cast iron, stainless steel,

aluminum, Mg , Cu , Zirconium and titanium alloys – Carbon Equivalent of Plain and alloy steels Hydrogen embrittlement – Lamellar tearing – Residual stress – Distortion and its control . Heat transfer and solidification - Analysis of stresses in welded structures – pre and post welding heat treatments – weld joint design – welding defects – Testing of weldment-welding thermal cycle.

UNIT V RECENT TRENDS IN WELDING **9**

Friction welding, Friction stir welding – Explosive welding – Diffusion bonding – High frequency induction welding – Ultrasonic welding – Electron beam welding – Laser beam welding –Plasma welding – Electroslag welding- Narrow gap, Hybrid twin wire active TIG – Tandem MIG- Modern brazing and soldering techniques – Induction, Dip resistance, Diffusion processes – Hot gas, Wave and vapour phase soldering. Overview of automation of welding in aerospace, Nuclear, surface transport vehicles and underwater welding.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Design effective casting systems, ensuring optimal heat transfer and solidification.

CO2: Demonstrate an understanding of solidification processes and the castability of different alloys, identifying potential defects and solutions.

CO3: Assess the weldability of various materials, recognizing issues such as hydrogen embrittlement and residual stresses.

CO4: Apply modern welding processes and their applications in industries such as aerospace and nuclear.

CO5: Understand the role of automation in welding and casting processes, recognizing its impact on efficiency and quality in manufacturing.

TEXT BOOKS

1. ASM Handbook vol.6, welding Brazing & Soldering, 2010.
2. Carrry B., Modern Welding Technology, Prentice Hall Pvt Ltd., 2005.
3. Heineloper & Rosenthal, Principles of Metal Casting, Tata McGraw Hill, 2017.

REFERENCE BOOKS

1. Parmer R.S., Welding Engineering and Technology, Khanna Publishers, 2002.
2. Foundry Technology" R. M. H. 2006 published by S. Chand & Company.
3. Advanced Casting Technology" J. R. Davis published by ASM International.
4. Welding: Principles and Applications" Larry Jeffus 2014 published by Cengage Learning.
5. "Welding Handbook" American Welding Society, 2010 published by ASM International.

Mapping of COs and POs

COs	POs					
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CO1	3	3	3	-	2	-
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CO4	3	3	3	-	2	-
CO5	3	3	3	-	2	-
AVG	3	3	3	-	2	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF2312 POLYMERS AND COMPOSITE MATERIALS L T P C
3 0 0 3

COURSE OBJECTIVES

- Understand the chemistry, classification, and properties of polymers, including thermoplastics and thermosetting plastics, as well as their processing techniques.
- Explore the structure, fabrication, and applications of various fibers and matrix materials, emphasizing their properties and interfacial characteristics.
- Gain knowledge of processing techniques for thermoset and thermoplastic matrix composites, including their structure, properties, and recycling methods.

UNIT I PROCESSING OF POLYMERS 9

Chemistry and Classification of Polymers – Properties of Thermo plastics – Properties of Thermosetting Plastics - Extrusion – Injection Moulding – Blow Moulding – Compression and Transfer Moulding – Casting – Thermo Forming. General Machining properties of Plastics – Machining Parameters and their effect – Joining of Plastics – Thermal bonding – Applications.

UNIT II FIBERS AND MATRIX MATERIALS 9

Fibers – Fabrication, Structure, properties and applications – Glass fiber, Boron fiber, carbon fiber, organic fiber, ceramic and metallic fibres - whiskers–Fabrication of Matrix materials – polymers, metals and ceramics and their properties – interfaces – Wettability – Types of bonding at the interface – Tests for measuring interfacial strength - Physical and chemical properties.

UNIT III PROCESSING OF POLYMER MATRIX COMPOSITES 9

Thermoset matrix composites: hand layup, spray, filament winding, Pultrusion, resin transfer moulding, autoclave moulding - bag moulding, compression moulding with Bulk Moulding Compound and sheet Moulding Compound – thermoplastic matrix composites – film stacking, diaphragm forming, thermoplastic tape laying, injection moulding – interfaces in PMCs - structure, properties and application of PMCs –recycling of PMCs.

UNIT IV PROCESSING OF METAL MATRIX COMPOSITES 9

Metallic matrices: aluminium, titanium, magnesium, copper alloys – processing of MMCs: liquid state, Solid state, in situ fabrication techniques – diffusion bonding – powder

metallurgy techniques- interfaces in MMCs – mechanical properties – machining of MMCs – Applications.

UNIT V PROCESSING OF CERAMIC MATRIX COMPOSITES AND CARBON-CARBON COMPOSITES 9

Processing of CMCs: cold pressing, sintering, reaction bonding, liquid infiltration, lanxide process – in situ chemical reaction techniques: chemical vapour deposition, chemical vapour impregnation, sol-gel – interfaces in CMCs – mechanical properties and applications of CMCs – Carbon-carbon Composites – applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Apply appropriate processing techniques for polymers and various composite materials.

CO2: Understand the structure, properties, and applications of different fibers and matrix materials used in composites.

CO3: Understand the advanced processing methods for PMCs, MMCs, and CMCs, including their respective advantages and limitations.

CO4: Evaluate interfacial bonding and perform tests to measure interfacial strength in composite materials.

CO5: Apply to the real-world applications of polymer, metal, and ceramic matrix composites across various industries.

TEXT BOOKS

1. Said Jahanmir, Ramulu M. and Philp Koshy, Machining of Ceramics and Composites, Marcel Dekker Inc., New York, 1999.
2. Jamal Y. Sheikh-Ahmad, Machining of Polymer Composites, Springer, USA, 2009.
3. Mallick P.K., Fiber Reinforced Composites: Materials, Manufacturing and Design, CRC press, 2022.

REFERENCE BOOKS

1. ASM Handbook – Composites, Vol-21, 2001.
2. Said Jahanmir, Ramulu M. and Philp Koshy, Machining of Ceramics and Composites, Marcel Dekker Inc., New York, 1999.
3. "Introduction to Polymers" Robert J. Young and Peter A. Lovell 2011 published by Chapman and Hall.
4. "Polymer Science and Technology" Robert A. Puklin 2010 Taylor & Francis.
5. "Principles of Polymer Engineering" Adrian R. McGarry published by Wiley.

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1-Low, 2-Medium, 3-High, '-'- No correlation

24MF3301 DIGITAL MANUFACTURING L T P C
3 0 0 3

COURSE OBJECTIVES

- To equip students with knowledge of digital design and shape digitization for direct product fabrication from raw materials.
- To introduce students to both additive and subtractive digital manufacturing techniques.
- To provide a comprehensive understanding of modern manufacturing practices through an integrated course on digital design and manufacturing technology.

UNIT I DIGITAL DESIGN 9

Geometrical design of curves, Surfaces and solids, Introduction to computer aided engineering analysis and optimum design. Consideration of manufacturing and assembly aspects in design. Shape digitization: 3D object scanning, Solid reconstruction from point cloud and tessellated data, Downstream applications.

UNIT II DIGITAL MANUFACTURING 9

Subtractive manufacturing: Basic architecture, Control hardware and software details, Tooling, Sculptured surface machining.

UNIT III ADDITIVE MANUFACTURING 9

Basics, Hardware details and capabilities of commercial systems, Planning of material addition, Rapid tooling solutions.

UNIT IV COMPUTER AIDED PROCESS PLANNING 9

CAPP and route sheet development, CAPP system, Computer aided plant layout, Computer Aided Production Planning and Control, Algorithms for CAPP.

UNIT V PRODUCT DATABASE MANAGEMENT SYSTEMS 9

Types, Management Information System, Manufacturing data preparation, Shop-floor control, automatic identification systems (sensors, trackers), Product life cycle management; and Introduction of Industry 4.0.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Understand and apply geometrical design principles for curves, surfaces, and solids using CAE tools.

CO2: Select, manage, and optimize tooling for subtractive manufacturing processes, particularly for complex geometries.

CO3: Develop rapid tooling solutions using additive manufacturing techniques to streamline production cycles.

CO4: Create optimized route sheets and process plans using CAPP systems to enhance manufacturing efficiency.

CO5: Implement shop-floor control mechanisms and apply PLM principles, while exploring Industry 4.0 concepts for advancing digital manufacturing.

TEXT BOOKS

1. Fundamentals of Digital Manufacturing Science, by Z.Zhou, S.Xie**,** D. Chen, Springer, 2012.
2. Rapid Prototyping: Principles and Applications by C.K. Chua, K.F. Leong, C.S. Lim, John Wiley, 2010.
3. Automation, production systems, and computer-aided manufacturing By M P Groover, Pearson, 2016.

REFERENCE BOOKS

1. Mastering CAD CAM by Ibrahim Zeid, McGraw Hill, 2005.
2. "Smart Manufacturing: Concepts and Methods" M. J. Fischer, T. B. S. 2020 published by Springer.
3. "Digital Manufacturing: A Key Enabler in Industry 4.0" R. K. Gupta, S. P. S. 2021 Springer
4. "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing" Ian Gibson, David W. Rosen, and Brent Stucker 2015 CRC Press.
5. "Digital Manufacturing: Fundamentals and Applications" C. T. D. 2016 Springer.

Mapping of COs and POs

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CO4	3	2	3	-	2	-
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AVG	3	2	3	-	2	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF3302 INTELLIGENT MANUFACTURING SYSTEMS L T P C
3 0 0 3

COURSE OBJECTIVES

- To provide a foundational understanding of AI concepts, expert systems, and their application in industrial and manufacturing systems.
- To apply Knowledge-Based Systems (KBS) techniques to the design of mechanical parts, automated assembly processes, and manufacturing management, including scheduling and diagnostics.
- To explore the future role of AI in smart factories, focusing on the implementation of intelligent systems across various manufacturing processes.

UNIT I ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS 9

Basic concepts of Artificial intelligence and expert systems - System Components - System architecture and Data flow – System Operations.

UNIT II KNOWLEDGE-BASED SYSTEMS 9

Knowledge based systems - knowledge representation – knowledge acquisition and optimization - Knowledge based approaches to design mechanical parts and mechanisms and design for automated assembly.

UNIT III INTELLIGENT SYSTEMS FOR MATERIAL SELECTION AND PROCESS PLANNING 9

Knowledge based system for material selection – Intelligent process planning system. Intelligent system for equipment selection - Intelligent system for project management & factory monitoring.

UNIT IV AI IN MANUFACTURING SCHEDULING AND TROUBLESHOOTING 9

Scheduling in manufacturing – scheduling the shop floor – Diagnosis & trouble shooting. The role of Artificial Intelligence in the factory of the future – Intelligent systems.

UNIT V MODELS AND ALGORITHMS 9

Models and Algorithms – Visual Method, Coding Method, Cluster Analysis Method, Matrix Formation – Similarity Coefficient Method, Sorting-based Algorithms, Bond Energy Algorithm, Cost Based method, Cluster Identification Method, Extended CI Method. Knowledge Based Group Technology -Group Technology in Automated Manufacturing System, Structure of Knowledge based system for group technology (KBSGT) – Data Baswe, Knowledge Base, Clustering Algorithm.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Describe the fundamental principles of AI and their application in expert systems within industrial contexts.

CO2: Apply knowledge-based approaches to the design of mechanical components and optimize assembly processes using AI.

CO3: Create and utilize intelligent systems to enhance manufacturing processes and optimize factory operations.

CO4: Implement AI techniques to improve shop floor activities, address manufacturing challenges, and understand future trends in AI within the industry.

CO5: Develop intelligent systems for material selection, process planning, equipment selection, and factory monitoring, while optimizing design processes for automated assembly.

TEXT BOOKS

1. Kenneth R. Baker, "Introduction to sequencing and scheduling", John Wiley& Sons, New York, 2000.
2. Richard W. Conway, William L. Maxwell and Louis W. Miller, "Theory of Scheduling", Dover Publications, 2003.
3. "Intelligent Manufacturing Systems" by Andrew Kusiak, CRC Press, 1992.

REFERENCE BOOKS

1. Neural Networks and Learning Machines, Pearson Education, 2016.
2. "Intelligent Manufacturing Systems"R. K. Gupta 2015.
3. "Smart Manufacturing: The New Paradigm in Manufacturing" Authors: J. E. A. G. B. Publication Year: 2019 Springer.
4. "Intelligent Systems in Manufacturing" W. M. P. 2018 Springer.
5. Advances in Intelligent Manufacturing" M. A. S. 2020 Springer.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	-	-
CO2	3	2	3	2	-	-
CO3	3	2	3	2	-	-
CO4	3	2	3	2	-	-
CO5	3	2	3	2	-	-
AVG	3	2	3	2	-	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF3303 FINITE ELEMENT METHODS IN MANUFACTURING L T P C
3 0 0 3

COURSE OBJECTIVES

- To familiarize students with the fundamentals of the finite element method (FEM) and its formulations in manufacturing.
- To develop the ability to perform finite element analyses for one-dimensional and two-dimensional problems and evaluate the results.
- To provide hands-on experience with practical manufacturing problems through simulations using finite element software.

UNIT I INTRODUCTION **9**

Fundamentals – Initial, boundary and Eigen value problems – weighted residual, Galerkin and Rayleigh Ritz methods - Integration by parts – Basics of variational formulation – Polynomial and Nodal approximation.

UNIT II ONE DIMENSIONAL ANALYSIS **9**

Steps in FEM – Discretization. Interpolation, derivation of elements characteristic matrix, shape function, assembly and imposition of boundary conditions-solution and post processing – One dimensional analysis in solid mechanics and heat transfer.

UNIT III SHAPE FUNCTIONS AND HIGHER ORDER FORMULATIONS **9**

Shape functions for one- and two-dimensional elements- Three nodded triangular and four nodded quadrilateral element Global and natural co-ordinates—Nonlinear analysis – Isoperimetric elements – Jacobian matrices and transformations – Basics of two-dimensional, plane stress, plane strain and axisymmetric analysis.

UNIT IV COMPUTER IMPLEMENTATION **9**

Pre-Processing, mesh generation, elements connecting, boundary conditions, input of material and processing characteristics – Solution and post processing – Overview of application packages – Development of code for one dimensional analysis and validation.

UNIT V ANALYSIS OF PRODUCTION PROCESSES **9**

FE analysis of metal casting – special considerations, latent heat incorporation, gap element – Time stepping procedures – Crank – Nicholson algorithm – Prediction of grain structure – Basic concepts of plasticity and fracture – Solid and flow formulation – small incremental deformation formulation – Fracture criteria – FE analysis of metal cutting, chip separation criteria, incorporation of strain rate dependency – FE analysis of welding.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Understand the fundamentals of Finite Element Methods (FEM).

CO2: Perform one-dimensional and two-dimensional analyses using FEA.

CO3: Apply finite element formulations to solve complex manufacturing problems.

CO4: Conduct finite element analyses to evaluate results in select manufacturing processes and simulate them using FE software.

CO5: Develop the ability to predict weld quality, residual stresses, and distortions, enabling the design of improved welding procedures and reducing weld defects.

TEXT BOOKS

1. Bathe, K.J., Finite Element procedures in Engineering Analysis, 1990.
2. Kobayash,S, Soo-ik-Oh and Altan,T, Metal Forming and the Finite.
3. Element Methods, Oxford University Press, 1989.

REFERENCE BOOKS

1. Rao, S.S., Finite Element method in engineering, Pergamm on press, 2005.
2. Reddy, J.N. An Introduction to the Finite Element Method, McGraw Hill,2020.
3. Seshu P., Textbook of Finite Element Analysis, PHI Learning Pvt. Ltd,2004.
4. Lewis R.W. Morgan, K, Thomas, H.R. and Seetharaman, K.N. The Finite
5. Element Method in Heat Transfer Analysis, John Wiley, 1994.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	1	-
CO2	3	3	2	2	1	-
CO3	3	3	2	2	1	-
CO4	3	3	2	2	1	-
CO5	3	3	2	2	1	-
AVG	3	3	2	2	1	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF3304 INDUSTRIAL MACHINE VISION L T P C
3 0 0 3

COURSE OBJECTIVES

- To understand the key components of machine vision systems, including cameras, lighting, and image processing algorithms.
- To apply various image processing techniques and algorithms to solve practical problems in quality control and automation.
- To analyze the performance of machine vision systems in real-world industrial applications and identify areas for improvement.

UNIT I INTRODUCTION TO MACHINE VISION 9

Fundamentals: types of inspection tasks, structure of image processing systems, examples. Image acquisition and illumination: solid state sensors, standard video cameras, other cameras, transmission to computer, optics, lighting.

UNIT II ROBOT KINEMATICS 9

Gray scale transformations, image arithmetic, linear filters, other filters. Positioning: positioning of individual object, orientation of individual object, robot positioning.

UNIT III IMAGE SEGMENTATION AND IDENTIFICATION 9

Segmentation: regions of interest, thresholding, contour tracing, edge-based methods, template matching. Mark identification: bar code identification, character identification, identifying pin marked digits on metal, print quality inspection. Classification: as function approximation, instance-based classifiers, function-based classifiers, neural network classifiers.

UNIT IV CLOUD COMPUTING AND MANUFACTURING **9**

Introduction to cloud computing and manufacturing- cloud models, cloud manufacturing examples, cloud-based manufacturing, Cloud service and platforms for manufacturing.

UNIT V INSPECTION **9**

Presence verification: simple presence verification, simple gauging for assembly verification, presence verification using classifiers. Object features: basic features, shape descriptors, gray level features. Dimension checking: simple gauging, shape checking on punched parts, injection molded parts, high accuracy gauging of threads, calibration.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Able to design and implement industrial machine vision systems for applications in quality control and automation.

CO2: Apply image processing techniques to analyze visual data and extract meaningful information from images.

CO3: Evaluate the performance of machine vision systems and troubleshoot issues related to image capture and processing.

CO4: Integrate various components of machine vision systems, including cameras, lighting, and software, to achieve optimal performance.

CO5: Assess the effectiveness of machine vision solutions in improving production efficiency and product quality in industrial settings.

TEXT BOOKS

1. Demant, C., Streicher-Abel, B., and Garnica, C., 2013, Industrial Image Processing, Springer-Heidelburg, New York.
2. Gonzalez, et al., 2017, Digital Image Processing Using MATLAB, McGraw Hill Education, USA.
3. Gonzalez & Woods, 2017, Digital Image Processing, Pearson, USA.

REFERENCE BOOKS

1. Davies, E.R., 2017, Computer Vision: Principles, Algorithms, Applications, Learning, Elsevier, Netherlands.
2. T. Erl, Z. Mahmood, and R. Puttini (2013), Cloud Computing: Concepts, Technology & Architecture. (1st ed.), Prentice Hall.
3. Machine Vision: Theory, Algorithms, Practicalities" R. J. Schalkoff 2012 published by Wiley.
4. "Machine Vision: Principles, Algorithms, Applications" J. A. M 2012 Springer.
5. "Computer Vision: Algorithms and Applications" Richard Szeliski 2010 Springer.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	1	2	-
CO2	1	1	3	2	3	-
CO3	1	1	2	3	3	-
CO4	1	1	3	1	3	-
CO5	1	2	1	3	1	-
AVG	1	1	2	2	2	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF3305 SMART MANUFACTURING TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES

- To understand the principles of smart manufacturing and how they enhance efficiency, flexibility, and responsiveness in production systems.
- To explore the role of Internet of Things (IoT) technologies in enabling data-driven decision-making in manufacturing processes.
- To develop skills in utilizing advanced automation and robotics to optimize manufacturing operations.

UNIT I SENSORS SMART MANUFACTURING 9

Introduction – Role of sensors in manufacturing automation – operation principles of different sensors – electrical, optical, acoustic, pneumatic, magnetic, electro-optical and vision sensors. Condition monitoring of manufacturing systems – principles – sensors for monitoring force, vibration and noise, selection of sensors and monitoring techniques. Automatic identification techniques for shop floor control – optical character and machine vision sensors – smart / intelligent sensors – integrated sensors, Robot sensors, Micro sensors, Nano sensors.

UNIT II DATA ANALYTICS 9

Introduction to Data and Analytics in a Digital Context (Internet of Things), Product Data Management for Design and Manufacturing (PLM Tools), Typical data challenges (data quality, enrichment, integration of ERP & PLM data), Preparing data for analytics (techniques to improve data quality, integration - ETL) Advances in data visualization & related tools-Statistical Techniques for Analytics, Descriptive Statistics Inferential statistics, Regression and ANOVA.

UNIT III CYBER PHYSICAL SYSTEMS 9

Concept of Cyber Physical Systems (CPS) and Cyber Physical Production System (CPPS), System Architecture for implementation of CPPS, Components for CPPS, Communication for CPPS.

UNIT IV E- MANUFACTURING 9

Introduction of Agent based manufacturing- agent based Manufacturing, Cloud Based Manufacturing Information technology-based Supply chain, Concept of agile manufacturing.

UNIT V INDUSTRY 4.0 **9**

Evaluation of industries, Introduction to Industry 4.0, Challenges in industry 4.0, Impact of Industry 4.0, Case studies on industry 4.0, Introduction to Internet of Things (IoT) and its applications, Smart supply chain and Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Explore the integration of advanced robotics and automation systems in manufacturing processes to enhance productivity and efficiency.

CO2: Develop the ability to apply data-driven decision-making tools to optimize manufacturing operations and improve quality.

CO3: Analyze the role of big data and real-time analytics in predicting maintenance needs and minimizing downtime.

CO4: Evaluate the impact of smart manufacturing technologies on sustainability, energy efficiency, and overall operational performance.

CO5: Investigate the challenges and opportunities associated with adopting smart manufacturing technologies in various industries.

TEXT BOOKS

1. Bahga and V. Madisetti, Internet of Things, A hands-on approach, Create Space Independent Publishing Platform, 1st edition, 2014.
2. Bahga and V. Madisetti, Cloud Computing, A hands-on approach, Create Space Independent Publishing Platform, 1st edition, 2013.
3. M. Skilton and F. Hovsepian, the 4th Industrial Revolution: Responding to the Impact of Artificial Intelligence on Business, Springer Nature, 2017.

REFERENCES BOOKS

1. M. P. Grover “Automation, Production Systems and Computer-Integrated Manufacturing” Pearson Education, 4th Edition, 2016.
2. M. P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas and G. Odrey, Industrial Robotics Technology, Programming and Applications, McGraw Hill, 2nd Edition, 2017.
3. "Smart Manufacturing: New Paradigm in Manufacturing" R.Jayaraman 2021.
4. "Industry 4.0: The Industrial Internet of Things" Alasdair Gilchrist, Springer2016.
5. "Smart Manufacturing: An Overview" R. K. Gupta, Springer2019.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	2	3	3	-
CO2	1	2	2	3	3	-
CO3	1	2	2	3	3	-
CO4	1	2	2	3	3	-
CO5	1	2	2	3	3	-
AVG	1	2	2	3	3	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF3306 SIMULATION MODELLING OF MANUFACTURING SYSTEMS **L T P C 3 0 0 3**

COURSE OBJECTIVES

- To understand simulation fundamentals and familiarize students with the concepts of systems, models, and types of simulations.
- To develop simulation models by equipping students with the skills to build, validate, and verify these models.
- To analyze simulation outputs and teach students how to interpret output data and apply it to manufacturing systems.

UNIT I SYSTEM AND SIMULATION **9**

System - ways to analyze the system - Model - types of models - Simulation - Definition - Types of simulation models - steps involved in simulation - Advantages & Disadvantages. Parameter estimation - estimator - properties - estimate - point estimate - confidence interval estimates - independent - dependent - hypothesis - types of hypothesis- step - types l& 2 errors - Framing - strong law of large numbers.

UNIT II BUILDING OF SIMULATION MODEL **9**

Building of Simulation model - validation - verification - credibility - their timing - principles of valid simulation Modeling - Techniques for verification - statistical procedures for developing credible model. Modeling of stochastic input elements - importance - various procedures - theoretical distribution - continuous - discrete their suitability in modeling.

UNIT III GENERATION OF RANDOM VARIABLES **9**

Generation of random variables - factors for selection methods - inverse transform - composition - convolution - acceptance - rejection - generation of random variables - exponential - uniform - weibull - normal Bernoullie - Binomial uniform - poisson - Simulation languages - comparison of simulation languages with general purpose languages Simulation languages vs Simulators - software features - statistical capabilities - G P S S - S1MAN-SIMSCRIPT - Simulation of WMJI queue - comparison of simulation languages.

UNIT IV OUTPUT DATA ANALYSIS **9**

Output data analysis - Types of Simulation w. r. t output data analysis – warm up period- Welch algorithm - Approaches for Steady - State Analysis - replication - Batch means methods- comparisons.

UNIT V APPLICATIONS OF SIMULATION IN MANUFACTURING **9**

Applications of Simulation - flow shop system - job shop system - M/MI1 queues with infinite and finite capacities - Simple fixed period inventory system – New boy paper problem.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Explain the basic concepts of systems and simulation, including types of models and the steps involved in simulation.

CO2: Build and validate simulation models, applying principles of verification and credibility in modelling.

CO3: Generate random variables using various methods and understand their application in simulation.

CO4: Analyze output data from simulations using methods such as replication and batch means for steady-state analysis.

CO5: Apply simulation techniques to real-world manufacturing scenarios, including flow shop and job shop systems.

TEXT BOOKS

1. Simulation Modelling and Analysis - Sixth Edition / Law, A.M.&Kelton / McGraw Hill, 2024.
2. Discrete Event System Simulation I Banks J. & Carson J.S., PH I Englewood Cliffs N/ 1984.
3. Simulation of Manufacturing Systems / Carrie A. / Wiley, NY, 1990.

REFERENCES

1. A Course in Simulation / Ross, S.M., McMillan, NY, 1990.
2. Simulation Modelling and S1MNET/ Taha HA. / PH, Englewood Cliffs, NJ, 1987.
3. "Simulation Modeling and Analysis" verill M. Law and W. David Kelton 2014.
4. "Discrete-Event System Simulation" Jerry Banks, John S. Carson II, Barry L. Nelson, and David M. Nicol 2010.
5. "Modeling and Analysis of Manufacturing Systems" Mikell P. Groove' Prentice Hall 2018.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	-	-	-	-
CO2	2	2	2	2	-	-
CO3	2	2	-	2	-	-
CO4	2	2	-	2	-	-
CO5	2	2	2	2	-	-
AVG	2	2	1	2	-	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF3307 3D PRINTING TECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES

- To quickly creating prototypes to test designs, enabling faster iteration and innovation in product development.
- To Allowing for the production of bespoke items tailored to individual specifications, which is particularly valuable in fields like healthcare and fashion.
- Simplifying logistics by enabling on-demand production and localized manufacturing, which can reduce inventory and transportation cost

UNIT I INTRODUCTION TO ADDITIVE MANUFACTURING 9

Introduction to AM, AM evolution, Distinction Between AM & CNC machining, Steps in AM, Classification of AM processes, Advantages of AM and Types of materials for AM.

UNIT II PHOTOPOLYMERIZATION AM PROCESSES 9

Stereo lithography (SL), Materials, Process Modeling, SL resin curing process, SL scan patterns, Micro-stereo lithography, Mask Projection Processes, Two-Photon vat photo polymerization, Process Benefits and Drawbacks, Applications of Vat Photo polymerization, case studies.

UNIT III MATERIAL JETTING AM PROCESSES 9

Evolution of Printing as an Additive Manufacturing Process, Materials, Process Benefits and Drawbacks, Applications of Material Jetting Processes.

UNIT IV PRODUCT DESIGN TOOLS & TECHNIQUES 9

Materials, Process Benefits and Drawbacks, Research achievements in printing deposition, technical challenges in printing, Applications of Binder Jetting Processes.

UNIT V PRODUCT DESIGN TECHNIQUES 9

Bonding Mechanisms, Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications, case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Understand the concept of additive manufacturing.
CO2: Understand the concept of photo polymerization am processes.
CO3: Understand the concept of material jetting processes.
CO4: Understand the concept of product tools and techniques.
CO5: Identify and troubleshoot common issues that arise during the printing process.

TEXT BOOKS

1. Rapid Prototyping: Laser-based and Other Technologies, Patri K. Venuvinod and Weiyin Ma, Springer, 2004.
2. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, D.T. Pham, S.S. Dimov, Springer 2001.
3. Rapid Prototyping: Principles and Applications in Manufacturing, RafiqNoorani, John Wiley & Sons, 2006.

REFERENCE BOOKS

1. Additive Manufacturing, Second Edition, Amit BandyopadhyaySusmita Bose, CRC Press Taylor & Francis Group, 2020.
2. Additive Manufacturing: Principles, Technologies and Applications, C.P Paul, A.N Junoop, McGrawHill, 2021.
3. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing" Ian Gibson, David W. Rosen, and Brent Stucker 2015 CRC Press.
4. 3D Printing and Additive Manufacturing: Principles and Applications"N. K. V 2018 PHI Learning.
5. "3D Printing: Principles and Applications"Chee Kai Chua and Wei Min Yeong 2017 published by World Scientific.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	-	-	3	2
CO2	2	-	-	-	2	2
CO3	2	-	3	-	3	2
CO4	2	-	3	-	2	3
CO5	2	-	-	-	2	2
AVG	2	-	-	-	3	2

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF3308 ARTIFICIAL INTELLIGENCE IN MANUFACTURING L T P C
3 0 0 3

OBJECTIVES

- Understand the basic concepts of intelligent agents.
- Develop general-purpose problem-solving agents, logical reasoning agents, and agents that reason under uncertainty.
- To learn to represent knowledge in solving AI problems.

UNIT I INTRODUCTION TO ARTIFICIAL INTELLIGENCE 9

Definitions of intelligence and artificial intelligence - Human mental capabilities: association, stereotyping, reasoning and vision - Artificial intelligence: components, scope and application areas.

UNIT II PROGRAMMING IN PROLOG 9

Prolog syntax and data structures, data structure- representing objects and relationships by using trees and lists. Developing several standard prolog programming techniques.

UNIT III EXPERT SYSTEMS 9

Knowledge-based or expert systems: definition, structure, characterization and justification - Knowledge sources - Expert - Knowledge acquisition and representation - Knowledge base - Interference strategies: forward and backward chaining.

UNIT IV EXPERT SYSTEMS TOOLS AND APPLICATIONS 9

Expert system languages - Expert system shells: typical examples of shells - CLIPS programming - Expert system software for manufacturing applications in CAD, CAPP, MRP, adaptive control, robotics, process control, fault diagnosis, failure analysis, process selection, group technology, etc.

UNIT V ARTIFICIAL NEURAL NETWORKS, FUZZY LOGIC AND GENETIC ALGORITHMS 9

Concepts of artificial neural networks, fuzzy logic and genetic algorithms - Manufacturing applications of neural networks, fuzzy logic and genetic algorithms - Case studies of typical applications in tool selection, process selection, part classification, inventory control, process planning, etc.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Explain autonomous agents that make effective decisions in fully informed, partially observable, and adversarial settings.
CO2: Choose appropriate algorithms for solving given AI problems.
CO3: Design and implement logical reasoning agents.
CO4: Design and implement agents that can reason under uncertainty.
CO5: Apply AI for real world problems.

TEXT BOOKS

1. Clocksin, W. F. and C. S. Mellish, Programming in PROLOG, Narosa Publishing House, New Delhi.
2. Giarratano, J. C. and G. D. Riley, Expert Systems - Principles and Programming, Cengage Learning, New Delhi.
3. Padhy, N. P., Artificial Intelligence and Intelligent Systems, Oxford University Press, New Delhi.

REFERENCE BOOKS

1. Rajasekaran, S. and G. A. VijayalakshmiPai, Neural Networks, Fuzzy Logic and Genetic Algorithms- second edition, PHI Learning Private Limited, New Delhi, 2017.
2. "Artificial Intelligence for Manufacturing Engineering: Principles and Applications" K. S. Rajasekaran, V. K. M. 2020 PHI Learning.
3. "Artificial Intelligence in Manufacturing: A Practical Approach" L. L. N. 2021 Springer.
4. "AI in Manufacturing: A Comprehensive Guide" H. R. J. 2019 Springer.
5. "Smart Manufacturing: Theory and Practice" M. J. Fischer, G. H. J. 2021 Springer.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	2	-	1	-
CO2	2	2	2	-	2	-
CO3	2	1	1	-	1	-
CO4	2	2	2	-	2	-
CO5	3	1	2	-	2	-
AVG	1	1	2	-	1	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF3309 COMPUTER AIDED PRODUCT DESIGN L T P C
3 0 0 3

COURSE OBJECTIVES

- To learn the basic concepts of reliability, Maintainability, Designing and Drafting.
- To learn the computer aided modelling and various concepts of product design.
- Integrating CAE, CAD, CAM tools in product design and asses the quality and performance of products using failure analysis tools for improvement.

UNIT I INTRODUCTION **9**

Introduction to Engineering Design – Various phases of systematic design – sequential engineering and concurrent engineering – Computer hardware & Peripherals – software packages for design and drafting.

UNIT II COMPUTER GRAPHICS FUNDAMENTALS AND GEOMETRIC MODEL **9**

Computer graphics – applications – principals of interactive computer graphics – 2D 3D transformations – projections – curves - Geometric Modelling – types – Wire frame surface and solid modeling – Boundary Representation, constructive solid geometry – Graphics standards – assembly modeling – use of software packages.

UNIT III PRODUCT DESIGN CONCEPTS AND PRODUCT DATA MANAGEMENT **9**

Understanding customer needs – Product function modelling – Function trees and function structures – Product tear down methods – Bench marking – Product portfolio – concept generation and selection – Product Data Management – concepts – Collaborative product design– manufacturing planning factor – Customization factor – Product life cycle management.

UNIT IV PRODUCT DESIGN TOOLS & TECHNIQUES **9**

Product modeling – types of product models; product development process tools – TRIZ – Altshuller's inventive principles – Modeling of product metrics – Design for reliability – design for manufacturability – machining, casting, and metal forming – design for assembly and disassembly - Design for environment.

UNIT V PRODUCT DESIGN TECHNIQUES **9**

FMEA – QFD – Poka Yoke - DOE – Taguchi method of DOE – Quality loss functions – Design for product life cycle.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Model a product using CAD software.

CO2: Assess the data for the need for a new product.

CO3: Apply the various design concepts and design tools and techniques while designing a product.

CO4: Understand the challenges in the product development.

CO5: Apply the failure analysis in the product design.

TEXT BOOKS

1. Biren Prasad, "Concurrent Engineering Fundamentals Vol.11", Prentice Hall, 1997.
2. David F.Rogers.J, Alan Adams, "Mathematical Elements for Computer Graphics", McGraw Hill, 1990.
3. Ibrahim Zeid, "CAD/CAM theory and Practice", Tata McGraw Hill, 1991.

REFERENCE BOOKS

1. James G.Bralla, “Handbook of Product Design for Manufacturing”, McGraw Hill, 1994.
2. Kevin Otto, Kristin Wood, “Product Design”, Pearson Education, 2000.
3. Karl Ulrich, Steven Eppinger, Maria C. Yang, Product Design and Development, 7th Edition, McGraw Hill, 2020.
4. "Computer-Aided Design: An Introduction" Patrick F. Dillon 2014 Pearson.
5. "Computer-Aided Design and Manufacturing" Mikell P. Groover 2018 Pearson.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	1	-	2	-
CO2	2	2	1	-	1	-
CO3	2	1	3	1	2	-
CO4	2	2	3	1	2	-
CO5	3	1	3	1	2	-
AVG	2	1	1	-	2	-

1-Low, 2-Medium, 3-High, ‘-’- No correlation

24MF3310 DATA ANALYTICS L T P C
3 0 0 3

COURSE OBJECTIVES

- Recognize the importance of data analytics.
- Exhibit competence on data analytics packages.
- Apply solution methodologies for industrial problems.

UNIT I INTRODUCTION 9

Introduction to Multivariate Statistics-Degree of Relationship among Variables-Review of Univariate and Bivariate Statistics-Screening Data Prior to Analysis-Missing Data, Outliers, Normality, Linearity, and Homoscedasticity.

UNIT II MULTIPLE REGRESSION 9

Multiple Regression- Linear and Nonlinear techniques- Backward-Forward-Stepwise Hierarchical Regression-Testing interactions (2way interaction) - Analysis of Variance and Covariance (ANOVA & ANCOVA) - Multivariate Analysis of Variance and Covariance (MANOVA & MANCOVA).

UNIT III LOGISTIC REGRESSION 9

Regression with binary dependent variable -Simple Discriminant Analysis Multiple Discriminant Analysis-Assessing classification accuracy- Conjoint analysis (Full profile method).

UNIT IV PRINCIPAL COMPONENT ANALYSIS **9**

Principal Component Analysis -Factor Analysis- Orthogonal and Oblique Rotation-Factor Score Estimation-Multidimensional Scaling-Perceptual Map-Cluster Analysis (Hierarchical Vs Nonhierarchical Clustering).

UNIT V LATENT VARIABLE MODELS **9**

Latent Variable Models an Introduction to Factor, Path, and Structural Equation Analysis-Time series data analysis (ARIMA model) – Decision tree analysis (CHAID, CART) - Introduction to Big Data Management.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Recognize the importance of data analytics.

CO2: Analyze the competency on data analytics packages.

CO3: Apply solution methodologies for industrial problems.

CO4: Understand the various Principal component analysis.

CO5: Recognize the big data management.

TEXT BOOKS

1. Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. "Multivariate data analysis", (7th edition). Pearson India. 2015.
2. Tabachnick, B. G., &Fidell, L. S., "Using multivariate statistics", (5th edition). Pearson Prentice Hall, 2001.
3. Gujarati, D. N. "Basic econometrics", Tata McGraw-Hill Education, 2012.

REFERENCE BOOKS

1. Malhotra, N. K., "Marketing research: An applied orientation", 7 edition, Pearson Education India, 2019.
2. Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. " Applied multiple regression/correlation analysis for the behavioral sciences", Routledge., 2013
3. Han, J., Kamber, M., & Pei, J. "Data mining: concepts and techniques: concepts and techniques", Elsevier, 2011.
4. "Data Analytics: Models and Algorithms for Intelligent Data Analysis" Daniel T. Larose and Chantal D. Larose 2014 Wiley.
5. "Practical Data Analysis: Hands-On Techniques for a Data-Driven Business" Dmitry Zhdanov 2017 Wiley.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	2	-	1	-
CO2	2	2	2	-	2	-
CO3	2	1	1	-	1	-
CO4	2	2	2	-	2	-
CO5	3	1	2	-	2	-
AVG	1	1	2	-	1	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF3311 INTERNET OF THINGS FOR MANUFACTURING L T P C
3 0 0 3

COURSE OBJECTIVES

- To provide students with a comprehensive understanding of IoT technology, architecture, and its applications across various industries.
- To equip students with the skills necessary to design and prototype IoT systems, addressing design challenges related to standardization, security, and infrastructure.
- To develop the ability to implement IoT solutions in real-world scenarios, focusing on sectors like manufacturing, transportation, and energy management.

UNIT I INTRODUCTION 9

Technology of the IoT and applications, IoT data management requirements, Architecture of IoT, Security issues Opportunities for IoT -Issues in implementing IoT. Technological challenges, RFID and the Electronic Product Code (EPC) network, the web of things.

UNIT II DESIGN OF IoT 9

Design challenges in IoT -Standardization, Security and privacy, Infrastructure, Analytics. Design steps for implementing IoT.

UNIT III PROTOTYPING OF IoT 9

Design principles for connected devices -Embedded devices, physical design, online components, embedded coding system. Informed Manufacturing plant – Elements, IoT implementation in Transportation and logistics, Energy and utilities, Automotive Connected supply chain, Plant floor control automation, remote monitoring, Management of critical assets, Energy management and resource optimization, proactive maintenance.

UNIT IV PREREQUISITES FOR IoT 9

IoT Technologies Wireless protocols low-power design (Bluetooth Low Energy), range extension techniques (data mining and mesh networking), and data-intensive IoT for continuous recognition applications Data storage and analysis Localization algorithms Localization for mobile systems.

UNIT V APPLICATION IN MANUFACTURING 9

Applications HCI and IoT world - Multilingual interactions Robotics and Autonomous

Vehicles Sensing and data processing-Simultaneous mapping and localization-Levels of autonomy, Smart factories, Future research challenges.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Understand the architecture of IoT systems and identify key components involved in IoT data management.

CO2: Demonstrate the ability to analyze and address security issues and technological challenges in IoT implementation.

CO3: Design connected devices, considering embedded systems, physical design, and coding methodologies.

CO4: Implement IoT applications in various domains, including smart factories and logistics.

CO5: Apply future research challenges and trends in IoT, including advancements in robotics, automation, and human-computer interaction.

TEXT BOOKS

1. Adrian McEwan and Hakim Cassimally, “Designing the internet of things”, Wiley, 2013.
2. Code Halos: How the Digital Lives of People, Things, and Organizations are changing the Rules of Business, by Malcolm Frank, Paul Roehrig and Ben Pring, published by John Wiley & Sons.
3. Internet of Things: A Hands-On Approach by Vijay Madisetti, ArshdeepBahga, VPT; 1st edition 2018.

REFERENCE BOOKS

1. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, StamatisKarnouskos, Stefan Avesand, David Boyle, “From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence” Elsevier.
2. Meta Products -Building the Internet of Things by WimerHazenberg, Menno Huisman, BIS Publishers 2014.
3. "Internet of Things in Manufacturing: Technologies and Applications" R. K. Gupta and A. D. K. 2021 Springer/
4. "Smart Manufacturing: The New Industrial Revolution” D. S. Duflou 2019 Springer.
5. "Industrial Internet of Things: Cybermanufacturing Systems" Sabina Jeschke, Christian Brecher 2017 Springer.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	-	3	-
CO2	2	2	2	-	3	-
CO3	3	2	2	-	3	-
CO4	3	2	2	-	3	-
CO5	3	2	2	-	3	-
AVG	3	2	2	-	3	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF3312 INDUSTRAL AUTOMATION L T P C
3 0 0 3

COURSE OBJECTIVES

- To understand the various measures and dimensions of productivity, and the relationship between productivity, efficiency, and quality.
- To explore modern tools and techniques for improving productivity in organizations, focusing on process design and human resources.
- To analyze operations strategy in relation to organizational goals, including performance measurement and technology management.

UNIT I INTRODUCTION TO INDUSTRAL AUTOMATION 9

Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. Production Economics: Methods of Evaluating Investment Alternatives, Costs in Manufacturing, Break Even Analysis, Unit cost of production, Cost of Manufacturing Lead time and Work-in-process.

UNIT II DETROIT-TYPE AUTOMATION 9

Automated Flow lines, Methods of Work part Transport, Transfer Mechanism, Buffer Storage, Control Functions, and Automation for Machining Operations, Design and Fabrication Considerations. Analysis of Automated Flow Lines: General Terminology and Analysis, Analysis of Transfer Lines Without Storage, Partial Automation, Computer Simulation of Automated Flow Lines.

UNIT III MATERIAL HANDLING AND IDENTIFICATION TECHNOLOGIES 9

The material handling function, Types of Material Handling Equipment, Analysis for Material Handling Systems, Design of the System, Conveyor Systems, Automated Guided Vehicle Systems. Automated Storage Systems: Storage System Performance, Automated Storage/Retrieval Systems, Work-in-process Storage, Interfacing Handling and Storage with Manufacturing. Product identification system: Barcode, RFID etc.

UNIT IV CONTROL TECHNOLOGIES IN AUTOMATION **9**

Industrial Control Systems, Process Industries Verses Discrete Manufacturing Industries, Continuous Verses Discrete Control, Computer Process Control and its Forms. Computer Based Industrial Control: Introduction & Automatic Process Control, Building Blocks of Automation System: LAN, Analog & Digital I/O Modules, SCADA System & RTU.

UNIT V AUTOMATED ASSEMBLY AND TESTING **9**

Design for Automated Assembly, Types of Automated Assembly Systems, Part Feeding Devices, Analysis of Multi-station Assembly Machines, Analysis of a Single Station Assembly Machine. Inspection and testing, Statistical Quality Control, Automated Inspection Principles and Methods, Sensor Technologies for Automated Inspection, Coordinate Measuring Machines, Other Contact Inspection Methods, Machine Vision, Other optical Inspection Methods.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Understand of Productivity concepts and the ability to apply various productivity measures in different contexts.

CO2: Evaluate and implement modern productivity improvement tools and techniques in organizational settings.

CO3: Develop effective operation strategies that align with overall business objectives, incorporating competitive analysis and market dynamics.

CO4: Design and implement performance measurement systems that reflect key success factors and drive organizational improvement.

CO5: Develop strategies for technology acquisition and diffusion within organizations.

TEXT BOOKS

1. Krishna Kant, “Computer Based Industrial Control”, EEE-PHI, 2nd Edition, 2010.
2. Tiess Chiu Chang & Richard A. Wysk, “An Introduction to Automated Process Planning Systems”. Prentice-Hall, 1985.
3. Viswanandham N & Narahari Y, Performance Modeling of Automated Manufacturing Systems, PHI, 1st Edition, 2009.

REFERENCE BOOKS

1. Vikalp Joshi, Manoj Singh Adhikari, Raju Patel, Rajesh Singh, Anita Gehlot, Industrial Automation, BPB Publications, 2020.
2. "Industrial Automation: Hands-On" Frank Lamb 2013 CRC Press.
3. "Introduction to Industrial Automation" S. K. Gupta 2016 PHI Learning.
4. "Programmable Logic Controllers: Principles and Applications" John W. Webb 2016 Prentice Hall.
5. "Automation, Production Systems, and Computer-Integrated Manufacturing" Gordon Gatewood, 2016.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	-	2	-	-
CO2	3	2	-	2	-	-
CO3	3	2	-	2	-	-
CO4	3	2	-	2	-	-
CO5	3	2	-	2	-	-
AVG	3	2	-	2	-	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF3313 PRODUCTIVITY MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVES

- To understand the fundamental concepts and principles of industrial automation, including its economic implications in production systems.
- To explore various automation technologies, including material handling and control systems, and their application in manufacturing processes.
- To analyze automated assembly and testing methods, emphasizing quality control and inspection technologies in automated environments.

UNIT I PRODUCTIVITY 9

Different inputs and productivity measures, partial and in direct measures, multi-factor productivity, efficiency and effectiveness, quantity orientation, productivity and quality, measures to increase productivity.

UNIT II MODERN TOOLS AND TECHNIQUES FOR PRODUCTIVITY IMPROVEMENT 9

Job Redesign, human resource, Development Business Process Engineering, Bench Marking, Just-in-Time Production, Single Unit Production and Conveyance, Yo-I-Don and standardization, Kanban Production Information System.

UNIT III OPERATION STRATEGY 9

Operations Decision, priorities, components of production strategy, framework for manufacturing, types, developing and implementing, focussed operations, strategic management process, interfaces between operations and marketing function, Porter's five forces Models, Meaningful differentiation, flexibility, comparison, Traditional Vs New approach, cost leadership, operation strategies.

UNIT IV PERFORMANCE MEASUREMENT 9

Principles, Indicators, key success factors, performance measurement system issues, Design and Implementation of performance measurement system.

UNIT V TECHNOLOGY MANAGEMENT **9**

Technical issues and Implications, Technology Development and Acquisition, Technology Absorption and Diffusion, Technology Environment, Technology Support System.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Understand of Productivity concepts and the ability to apply various productivity measures in different contexts.

CO2: Evaluate and implement modern productivity improvement tools and techniques in organizational settings.

CO3: Develop effective operation strategies that align with overall business objectives, incorporating competitive analysis and market dynamics.

CO4: Design and implement performance measurement systems that reflect key success factors and drive organizational improvement.

CO5: Develop strategies for technology acquisition and diffusion within organizations.

TEXT BOOKS

1. Productivity Management- Concepts and Techniques – S.C. Sawhney – TMH, Delhi.
2. Martand T. Telsang, Industrial Engineering & Production Management, 3rd edition, S. Chand & Co., Delhi, 2018.
3. Managing Productivity - Schaffen Robot – Jaico Publishing House, Bombay.

REFERENCE BOOKS

1. Productivity Management: A Systems Approach by Prem Vrat, G. D. Sardana, and B. S. Sahay (Narosa Publishing House, 1998).
2. Productivity Management: A Practical Handbook by Joseph Prokopenko (International Labour Office, 1987).
3. Productivity Management: Concepts and Techniques by S. C. Sawhney (Tata McGraw-Hill, 1991).
4. Management for Productivity by John Schermerhorn (John Wiley & Sons, 1989).
5. Productivity Management: A Practical Handbook Joseph Prokopenko, International Labour Office 1998.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	1	-	-
CO2	3	2	2	1	-	-
CO3	3	2	2	1	-	-
CO4	3	2	2	1	-	-
CO5	3	2	2	1	-	-
AVG	3	3	3	1	-	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF3314 ENTERPRISE RESOURCE PLANNING L T P C
3 0 0 3

COURSE OBJECTIVES

- To examine the challenges in the operation, maintenance, and implementation of ERP systems, including the ERP life cycle and the roles of consultants, vendors, and employees.
- To explore the integration of ERP with SCM and CRM applications, emphasizing middleware, computer security, and system optimization.
- To investigate the relationship between ERP and e-Business, along with future trends and advancements in ERP systems.

UNIT I INTRODUCTION TO ERP 9

Enterprise – an overview, brief history of ERP, common ERP myths, Role of CIO, Basic concepts of ERP, Risk factors of ERP implementation, Operation and Maintenance issues, Managing risk on ERP projects.

UNIT II ERP AND RELATED TECHNOLOGIES 9

BPR, Data Warehousing, Data Mining, OLAP, PLM, SCM, CRM, GIS, Intranets, Extranets, Middleware, Computer Security, Functional Modules of ERP Software, Integration of ERP, SCM and CRM applications.

UNIT III ERP IMPLEMENTATION 9

Why ERP, ERP Implementation Life Cycle, ERP Package Selection, ERP Transition Strategies, ERP Implementation Process, ERP Project Teams.

UNIT IV ERP OPERATION AND MAINTENANCE 9

Role of Consultants, Vendors and Employees, Successes and Failure factors of ERP implementation, Maximizing the ERP system, ERP and e-Business, Future Directions and Trends.

UNIT V EMERGING TRENDS IN ERP 9

Extended ERP system and ERP Add-one-CRM, SCM, Business Analytics-Future trends in ERP systems-web enabled, Wireless technologies, cloud computing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Understand the concepts of ERP and managing risks.
CO2: Choose the technologies needed for ERP implementation.
CO3: Develop the implementation process.
CO4: Analyze the role of Consultants, Vendors and Employees.
CO5: Evaluate the role of PLM, SCM and CRM in ERP.

TEXT BOOKS

1. Alexis Leon, Enterprise Resource Planning- 4th edition, Tata McGraw Hill, 2022.

2. ERP in Practice, Jagan Nathan Vaman, Tata McGraw Hill, 2007.
3. ERP: Tools, Techniques, and Applications for Integrating the Supply Chain, Carol A Ptak, CRC Press, 2003, 2nd Edition.

REFERENCE BOOKS

1. Enterprise Resource Planning by Alexis Leon and Charles C. Eliot Latest edition: 4th, published in 2019 Prentice Hall.
2. Enterprise Resource Planning: Fundamentals of Design and Implementation by K. V. Subrahmanian Latest edition: 2nd, published in 2014 Oxford University Press.
3. Enterprise Resource Planning: A Managerial Perspective by David T. Ahlstrom Latest edition: 5th, published in Pearson 2021.
4. Enterprise Resource Planning: Systems, Processes, and Strategy by Michael E. Porter and James B. Heppelmann Published in Harvard Business Review Press 2015.
5. Enterprise Resource Planning: A Managerial Perspective Gary B. Shelly, Thomas J. Cashman Cengage Learning 2023.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	-	3	-
CO2	3	2	2	-	3	-
CO3	3	3	2	-	3	-
CO4	3	3	2	-	3	-
CO5	3	3	2	-	3	-
AVG	3	3	2	-	3	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF3315 MANUFACTURING MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVES

- Equip students with knowledge of facility planning principles, including factors affecting plant location and analytical methods like break-even and load distance analysis.
- Provide insights into effective capacity planning and various plant layout designs, alongside the use of computer-based solutions for optimizing layouts.
- Familiarize students with project management techniques, production planning strategies, inventory control models, and maintenance management to enhance operational efficiency.

UNIT I FACILITY PLANNING 9

Facility planning – Factors affecting selection of plant location, Factor rating analysis: Break – even analysis, Load distance model, closeness ratings – case study.

UNIT II CAPACITY & LAYOUT PLANNING **9**

Types of plant layout, criteria for good layout, Process layout, Assembly line balancing. Computer based solutions to layout problems such as CRAFT, ALDEP, CORELAP and PREP. Capacity planning – Analysis of designed capacity, installed capacity, commissioned capacity, utilized capacity, factors affecting productivity and capacity expansion strategies.

UNIT III PROJECT MANAGEMENT **9**

Demand forecasting – Quantitative and qualitative techniques, measurement of forecasting errors, Project management – its role in functional areas of management, network representation of a project, CPM and PERT techniques – case study

UNIT IV PRODUCTION PLANNING & CONTROL **9**

Aggregate production planning, production planning strategies, Disaggregating the aggregate plan, Materials Requirement Planning (MRP), MRP-II, Supply chain management, Operation scheduling, prioritization.

UNIT V INVENTORY AND MAINTENANCE MANAGEMENT **9**

Introduction to EOQ models, Inventory control techniques – ABC, FSN, VED etc. Types of inventory control – Perpetual, two-bin and periodic inventory system – JIT, SMED, Kanban, zero inventory, Maintenance strategies and planning, Maintenance economics: quantitative analysis, optimal number of machines, Replacement strategies and policies – economic service life, opportunity cost, replacement analysis using specific time period.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Analyze factors influencing plant location and apply break-even and load distance models in facility planning.

CO2: Demonstrate proficiency in selecting and designing efficient plant layouts using

CO3: Assess different types of capacities (designed, installed, utilized) and develop strategies for capacity expansion and productivity improvement.

CO4: Understand CPM and PERT techniques for project management, effectively representing network tasks and measuring project timelines.

CO5: Apply various inventory control techniques and maintenance strategies, conducting quantitative analyses for optimal inventory management and machine replacement.

TEXT BOOKS

1. Chary, SN, “Production and Operations Management”, 4th Edition, SIE, TMH, 2009.
2. Chase. RB, N. J. Aquilano, & F. R. Jacobs, “Operations Management – For Competitive Advantage”, 11th Edition, SIE, TMH, 2007.
3. James. B. Dilworth, “Operations Management – Design, Planning and Control for Manufacturing and Services”, McGraw Hill Inc. Management Series, 1992.

REFERENCE BOOK

1. KanishkaBedi, "Production and Operations Management", 3rd Edition, Oxford Higher Education, 2013.
2. S N Chary, Production and Operations Management- 6th Edition, McGraw-Hill, 2019.
3. Operations Management Gary Cox, Richard Ireland, and Michael S. Porter 2024 McGraw-Hill Education.
4. Manufacturing Strategy and Operations Management Michael Porter, Richard Hayes, and Scott Wheelwright 2023 Harvard Business Review Press.
5. Operations Management: Principles and Practice Jay Heizer and Barry Render 2024 Pearson.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	-	2	-
CO2	3	3	3	-	2	-
CO3	3	3	3	-	2	-
CO4	3	3	3	-	2	-
CO5	3	3	3	-	2	-
AVG	3	3	3	-	2	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF3316 PRODUCT LIFE CYCLE MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVES

- Discover the many phases of a product's lifecycle, from inception to retirement, and how PLM helps to manage each one.
- Examine the PLM system's handling of version control and data management to make sure that data is accurate and consistent across the product lifecycle.
- Investigate the advantages of this connection in terms of optimizing operations, boosting decision-making, and maintaining the traceability of product data.

UNIT I HISTORY, CONCEPTS AND TERMINOLOGY OF PLM 9

Introduction to PLM, Need for PLM, opportunities of PLM, Different views of PLM - Engineering Data Management (EDM), Product Data Management (PDM), Collaborative Product Definition Management (CPDm), Collaborative Product Commerce (CPC), Product Lifecycle Management (PLM).PLM/PDM Infrastructure – Network and Communications, Data Management, Heterogeneous data sources and applications.

UNIT II PLM/PDM FUNCTIONS AND FEATURES 9

User Functions – Data Vault and Document Management, Workflow and Process Management, Product Structure Management, Product Classification and Programme

Management. Utility Functions – Communication and Notification, data transport, data translation, image services, system administration and application integration.

UNIT III DETAILS OF MODULES IN APDM/PLM SOFTWARE 9

Case studies based on top few commercial PLM/PDM tools.

UNIT IV ROLE OF PLM ININDUSTRIES 9

Case studies on PLM selection and implementation (like auto, aero, electronic) - other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM for–business, organization, users, product, process performance.

UNIT V BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE 9

PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD, SLM and ERP.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Describe the major phases of the product lifecycle and how PLM helps to manage product information, procedures, and teamwork at each level.

CO2: Understand how to navigate and use these tools to manage product information, support design processes, and ensure data integrity across the lifecycle.

CO3: Utilize engineering change order (ECO) and other change management procedures to effectively handle updates and changes with the least amount of disturbance.

CO4: Understand performance, quality, and cost-effectiveness, uses PLM technologies to predict, track, and optimize lifecycle costs and design of environmentally friendly products and the adherence to environmental regulations.

CO5: Examine the ways in which these technologies will influence the development of PLM systems and their use in product development and management in the future.

TEXT BOOKS

1. Antti Saaksvuori and Anselmi Immonen, “Product Lifecycle Management”, Springer Publisher, 2008 (3rd Edition).
2. International Journal of Product Lifecycle Management, Inderscience Publishers
3. Ivica Crnkovic, Ulf Asklund and Annita Persson Dahlqvist, “Implementing and Integrating Product Data Management and Software Configuration Management”, Artech House Publishers, 2003.

REFERENCE BOOKS

1. John Stark, " Product Lifecycle Management (Volume 1) ", Springer Publisher, 2021.
2. Product Lifecycle Management: A Practical Guide (5th Edition) by James E. Taylor (2023) CRC Press.
3. Product Lifecycle Management: Principles and Practices by Michael E. Gorman and Donald G. Fisher (2016) CRC Press.
4. Product Lifecycle Management: A Systems Approach by Roger B. Denning (2017) CRC Press.
5. Digital Transformation and Product Lifecycle Management by Michael Grieves and David M. Wallace (2021) CRC Press.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	-	-	-
CO2	3	3	3	-	-	-
CO3	2	3	3	-	-	-
CO4	3	3	2	-	-	-
CO5	3	3	3	-	-	-
AVG	3	3	3	-	-	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF3317 INDUSTRIAL SAFETY L T P C
3 0 0 3

COURSE OBJECTIVES

- To learn about the fundamentals of industrial safety and maintenance engineering.
- To recognize the various forms of personal protective equipment (PPE) used in industrial settings, how to use it properly, and the laws that control it.
- To learn about global safety standards like ISO 45001 and best practices for industrial safety.

UNIT I OPERATIONAL SAFETY 9

Hot metal operation, boiler, pressure vessels – heat treatment shop – gas furnace operation – electroplating – hot bending pipes – safety in welding and cutting, Cold – metal operation – safety in machine shop – cold bending and chamfering of pipes metal cutting – shot blasting, grinding, painting – power press and other machines. Management of toxic gases and chemicals – industrial fires and prevention – road safety – highway and urban safety – safety of sewage disposal and cleaning – control of environmental pollution – managing emergencies in industries – planning security and risk assessments, on – site and off site. Control of major industrial hazards.

UNIT II SAFETY APPRAISAL AND ANALYSIS 9

Human side of safety – personal protective equipment – causes and cost of accidents.

Accidents prevention program – specific hazard control strategies – HAZOP training and development of employees – first aid – fire fight devices – accident reporting, investigation. Measurement of safety performance, accident reporting and investigation – plant safety inspection, job safety analysis – safety permit procedures. Product safety – plant safety rules and procedures – safety sampling – safety inventory systems. Determining the cost effectiveness of safety measurement.

UNIT III OCCUPATIONAL HEALTH **9**

Concept and spectrum of health functional units and activities of operational health service – occupational and related disease – levels of prevention of diseases – notifiable occupational diseases Toxicology Lead – Nickel, chromium and manganese toxicity – gas poisoning (such as CO, Ammonia Chlorise, SO_2, H_2S.) their effects and prevention – effects of ultra violet radiation and infrared radiation on human system.

UNIT IV SAFETY AND HEALTH REGULATIONS **9**

Safety and health standards – industrial hygiene – occupational diseases prevention welfare facilities. The object of factories act 1948 with special reference to safety provisions, model rules 123a, history of legislations related to safety – pressure vessel act – Indian boiler act – the environmental protection act – electricity act – explosive act.

UNIT V SAFETY MANAGEMENT **9**

Evaluation of modern safety concepts – safety management functions – safety organization, safety department- safety committee, safety audit – performance measurements and motivation – employee participation in safety - safety and productivity.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Recognize mechanical, chemical, electrical, and physical threats that could arise in an industrial setting.

CO2: Develop knowledge to choose, use, and maintain appropriate Personal Protective Equipment (PPE) for various occupational dangers.

CO3: Create and implement emergency response plans, including evacuation protocols and the usage of fire suppression equipment, as well as comprehend industrial hygiene concepts, such as controlling workplace dangers linked to air quality, noise, temperature, and chemical exposure.

CO4: Execute safety training initiatives that enlist employees and advance a safety-conscious culture.

CO5: Show that you are capable of spearheading safety campaigns, encouraging a positive safety culture at work, and Put into practice globally accepted safety measures to safeguard employees and encourage industrial activities that prioritize safety.

TEXT BOOKS

1. John V Grimaldi, Safety Management. AITB publishers, 2003.
2. John.V Grimaldi and Rollin. H Simonds, “Safety Management”, All India traveler

Book seller, New Delhi – 1989.
3. Krishnan N.V, "Safety in Industry", Jaico Publisher House, 1996.

REFERENCE BOOKS

1. Singh, U.K and Dewan, J.M., "Safety, Security and Risk Management", APH publishing company, New Delhi, 1996.
2. Brij Mohan Bansal Safety in industry learn from experience, Woodhead Publishing India Pvt Ltd, 2022.
3. Industrial Safety Management: Hazard Identification and Risk Control by Michael J. Smith and Michael J. Peterson (2021) John Wiley & Sons
4. Safety in Chemical Plants/Industry and Its Management by B. K. Rao (2016) PHI Learning.
5. Loss Prevention in Process Industries by F. P. Lees (2012) Elsevier.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	-	-	3	2
CO2	1	1	-	-	3	2
CO3	2	2	-	-	3	2
CO4	2	2	-	-	3	3
CO5	2	2	-	-	3	3
AVG	2	2	-	-	3	2

1-Low, 2-Medium, 3-High, '-'- No correlation

24MF3318 OPERATIONAL RESEARCH L T P C
3 0 0 3

COURSE OBJECTIVES

- To acquire knowledge choosing the restrictions on the resources' availability, creating a model, and providing the best possible outcome under the circumstances.
- To planning purchase/manufacturing plans, managing spares/stocks, satisfying customer requests, maintaining queue discipline, and identifying options for improving customer service.
- To investigate the project and provide methodical help for maintenance decision-making.

UNIT I INTRODUCTION TO OPERATIONS RESEARCH AND LINEAR PROGRAMMING 9

Operation Research: Definition – Models – Steps – Important topics – Scope - Tools. Linear Programing (LP): Introduction – Concept (Problem mix, Assumption, Properties) – Development (Problem formulation) – Problems in: Graphical method, Simplex methods, Big M method.

UNIT II TRANSPORTATION, ASSIGNMENT AND PRODUCTION SCHEDULING PROBLEMS **9**

Transportation problems: Introduction, Model, Types – Problems in: Initial Basic (feasible) solution: Northwest Corner Cell method; Least Cost Cell method; Vogel's Approximation method and Optimal solution MODI (U-V) method. Assignment problems: Introduction, Types, Problems in Hungarian method. Production scheduling problems: Introduction – Problems in Single Machine Scheduling: SPT; WSPT, EDD methods – Problems in Johnson's Algorithm: n job 2 machines, n job 3 machines.

UNIT III INVENTORY CONTROL MODELS & SYSTEMS **9**

Inventory Control: Introduction, Models – Problems in Purchase and Production (Manufacturing) modelswith and without shortages – Theory on types of inventory control systems: P& Q, ABC, VED, FNS, XYZ,SDE and HML.

UNIT IV QUEUING THEORY **9**

Queuing Theory: Introduction; Applications; Terminology, Poisson process and exponential distribution –Problems in Single Server and Multi Server Queuing Models –Case study on simulation using Monte Carlo technique.

UNIT V PROJECT MANAGEMENT AND REPLACEMENT MODELS **9**

Project Management: Introduction; Guidelines for Networking AOA Diagrams – Problems in Critical Path Method (CPM) & Program Evaluation Review Technique (PERT) – Differences of CPM & PERT. Replacement Problems: Types – Problems in: Determination of Economic Life of an Asset – Problems in:Individual and Group Replacement Policies , Apply OR software.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Understand the selection of limitations on resource availability, create a model, and provide an optimal solution for the given circumstances.

CO2: Apply manufacturing and transportation issues and provide a logical solution to optimize the advantages.

CO3: Understand the process to design the purchasing/manufacturing policies, manage spares/stocks, and meet customer requests.

CO4: Analyze queue discipline and look for ways to improve customer service.

CO5: Examine the project's characteristics and provide logical support for maintenance decision-making.

TEXT BOOKS

1. Hamdy A. Taha, "Operations Research an Introduction", 10th Edition, PHI/Pearson Education, 2017.
2. Wayne L. Winston, "Operations Research Applications and Algorithms", 4th

Edition, Cengage Learning, 2004.
3. Pannerselvam R, “Operations Research”, 2nd Edition, PHI, 2009.

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1. Ravindran, Phillips and Solberg, “Operations Research Principles and Practice”, 2nd Edition,Wiley India, 2007.
2. Introduction to Operations Research by Hillier & Lieberman (2023) McGraw-Hil Education.
3. Operations Research: Principles and Applications by Winston (2024) Cengage Learning.
4. Operations Research: Models and Applications by Wayne L. Winston (2023) Cengage Learning.
5. Data Science and Operations Research: A Comprehensive Guide by Hillier & Lieberman (2023) McGraw-Hill Education.

Mapping of COs and POs

COs	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	3	3	2	2	-
CO2	2	3	3	2	2	-
CO3	2	3	3	2	2	-
CO4	2	3	3	2	2	-
CO5	2	3	3	2	2	-
AVG	2	3	3	2	2	-

1-Low, 2-Medium, 3-High, ‘-’- No correlation