DEPARTMENT OF MECHANICAL ENGINEERING

ANNA UNIVERSITY, CHENNAI

VISION OF THE DEPARTMENT

To be recognized globally for its academic, industrial and research excellence in the field of Mechanical and allied Engineering disciplines.

MISSION OF THE DEPARTMENT

1. To provide world class education through the conduct of pioneering and cutting–edge research for students and faculty to make impactful contribution to the society.
2. To expand the frontiers of engineering and science in technological innovation while fostering academic excellence and scholarly learning in a collegial environment.
3. To attract highly motivated students with enthusiasm, aptitude and interest in the field of Mechanical and allied Engineering.
4. To excel in industrial collaboration and research leading to innovative technology development and transfer.
5. To serve the society with Innovative and entrepreneurially competent graduates for the national and international community towards achieving the sustainable development goals.

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ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

M.E. MANUFACTURING SYSTEMS AND MANAGEMENT (FULL - TIME)

REGULATIONS 2023

CHOICE BASED CREDIT SYSTEM

I TO IV SEMESTERS CURRICULA & SYLLABI

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

Master of Manufacturing Systems and Management curriculum is designed

I.	To prepare students to excel in research and to succeed in the areas of manufacturing systems engineering and manufacturing management.
II.	To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to solve manufacturing systems engineering related problems.
III.	To train students with scientific and engineering knowledge so as to comprehend, analyze, design and solve the real time problems.
IV.	To inculcate students with professional and ethical attitude, effective communication skills, teamwork skills and multidisciplinary approach.
V.	To develop student with an academic excellence, leadership qualities, leading to life-long learning for a successful professional career.

2. PROGRAMME OUTCOMES(POs):

PO	Programme Outcomes
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 in Manufacturing system and management.
4	An ability to understand the complex manufacturing systems through the application of modelling, simulation tools, techniques and methodologies.
5	An ability to apply management, quality principles and data analytics in the area of manufacturing.
6	Apply advanced manufacturing systems to improve productivity and sustainability.

3. PEO/PO Mapping:

PEO	PO					
	1	**2**	**3**	**4**	**5**	**6**
I.	**3**	**3**	**2**	**3**	**3**	**3**
II.	**3**	**2**	**3**	**3**	**3**	**3**
III.	**3**	**2**	**3**	**3**	**3**	**3**
IV.	**1**	**3**	**3**	**3**	**3**	**3**
V.	**3**	**3**	**3**	**1**	**3**	**3**

1,2,3, -, scale against the correlation POs with PEO's

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PROGRAM ARTICULATION MATRIX OF M.E. / M. TECH MANUFACTURING SYSTEMS AND MANAGEMENT

		COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6
YEAR I	SEMESTER I	Statistical Quality Control for Manufacturing Systems	1.5	2	2	2	1	1.5
		Manufacturing Management	2		3	1.67	3	1.33
		Digital Manufacturing	3		2.8	3	1.8	3
		Logistics and Supply Chain Management for Manufacturing Systems	3	3	3	2	2	3
		Research Methodology and IPR	3	3	2	-	-	-
		Professional Elective I						
		Manufacturing Systems Laboratory	3	2.7	3	2	2.3	2.3
		Technical Seminar						
	SEMESTER II	Lean Manufacturing Systems and Six Sigma	2.4	1.4	2.4	2.25	2.8	2.6
		Enterprise Resource Planning for Manufacturing	2.67	1.17	2.67	2.50	2.17	1.67
		Experimental Design and Analysis	3	3	3	3	3	2
		Maintenance and Reliability Engineering	1.5		3	2	3	1.5
		Professional Elective II						
		Professional Elective III						
		Manufacturing Analytics Laboratory	3	2.3	3	2.7	3	3
		Industrial Training/Internship*						
YEAR II	SEMESTER III	Professional Elective IV						
		Professional Elective V						
		Professional Elective VI						
		Project Work I						
	SEMESTER IV	Project Work II						

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ELECTIVES	PO1	PO2	PO3	PO4	PO5	PO6
Product Design for Manufacturing	3	2	3	3	2	2
Mechatronics in Manufacturing	2	1	3	3	2	3
Operation Research for Manufacturing Systems	3	3	3	3	2	2
Solid Freeform Manufacturing	2.6	2.4	2.4	2.2	2.6	2.4
Advanced Materials and Processing	3		2			3
Human Resource Management	2.6	2.2	1.5	2.5	1.5	2
Modern Techniques of Materials Characterization	3	2			2	2
Sustainable and Green Manufacturing	2.8	1	3	2.2	2.6	3
Integrated Product Design and Development	3	3	3	3	2	3
Financial Management and Accounting	3	2.4	1.8	1	3	1.6
Material Handling Systems and Design	2		3	2	2	3
Materials Management	3		2	1		3

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UNIVERSITY DEPARTMENTS

REGULATIONS - 2023

CHOICE BASED CREDIT SYSTEM

M.E. MANUFACTURING SYSTEMS AND MANAGEMENT (FULL - TIME)

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MS3101	Statistical Quality Control for Manufacturing Systems	FC	2	1	0	3	3
2.	MS3102	Manufacturing Management	PCC	3	0	0	3	3
3.	MS3103	Digital Manufacturing	PCC	3	0	0	3	3
4.	MS3104	Logistics and Supply Chain Management for Manufacturing Systems	PCC	3	0	0	3	3
5.	RM3151	Research Methodology and IPR	RMC	2	1	0	3	3
6.		Professional Elective I	PEC	3	0	0	3	3
PRACTICALS								
7.	MS3111	Manufacturing Systems Laboratory	PCC	0	0	4	4	2
8.	MS3112	Technical Seminar	EEC	0	0	4	4	2
			TOTAL	**16**	**2**	**8**	**26**	**22**

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MS3201	Lean Manufacturing Systems and Six Sigma	PCC	3	0	0	3	3
2.	MS3202	Enterprise Resource Planning for Manufacturing Systems	PCC	3	0	4	7	5
3.	MS3203	Experimental Design and Analysis	PCC	2	1	0	3	3
4.	MS3204	Maintenance and Reliability Engineering	PCC	3	0	0	3	3
5.		Professional Elective II	PEC	3	0	0	3	3
6.		Professional Elective III	PEC	3	0	0	3	3
PRACTICALS								
7.	MS3211	Manufacturing Analytics Laboratory	PCC	0	0	4	4	2
8.	MS3212	Industrial Training/Internship*	EEC	0	0	0	0	2
			TOTAL	**17**	**1**	**8**	**26**	**24**

* The students will undergo industrial training / Internship during the second semester vacation.

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SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Professional Elective IV	PEC	3	0	0	3	3
2.		Professional Elective V	PEC	3	0	0	3	3
3.		Professional Elective VI	PEC	3	0	0	3	3
PRACTICALS								
4.	MS3311	Project Work I	EEC	0	0	12	12	6
			TOTAL	**9**	**0**	**12**	**21**	**15**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	MS3411	Project Work II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 73

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FOUNDATION COURSE [FC]

Sl. No.	Course Code	Course Title	Periods per week			Credits	Semester
			L	T	P		
1.	MS3101	Statistical Quality Control for Manufacturing Systems	2	1	0	3	1

PROGRAM CORE COURSES (PCC)

Sl. No.	Course Code	Course Title	Periods per week			Credits	Semester
			L	T	P		
1.	MS3103	Digital Manufacturing	3	0	0	3	1
2.	MS3102	Manufacturing Management	3	0	0	3	1
3.	MS3104	Logistics and Supply Chain Management for Manufacturing Systems	3	0	0	3	1
4.	MS3111	Manufacturing Systems Laboratory	0	0	4	2	1
5.	MS3201	Lean Manufacturing Systems and Six Sigma	3	0	0	3	2
6.	MS3202	Enterprise Resource Planning for Manufacturing Systems	3	0	4	5	2
7.	MS3203	Experimental Design and Analysis	2	1	0	3	2
8.	MS3204	Maintenance and Reliability Engineering	3	0	0	3	2
9.	MS3211	Manufacturing Analytics Laboratory	0	0	4	2	2

PROFESSIONAL ELECTIVE COURSES

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MS3052	Product Design for Manufacturing	PEC	3	0	0	3	3
2.	MN3052	Mechatronics in Manufacturing	PEC	3	0	0	3	3
3.	MS3001	Operation Research for manufacturing systems	PEC	3	0	0	3	3
4.	CI3151	Solid Freeform Manufacturing	PEC	3	0	0	3	3
5.	MS3002	Advanced Materials and Processing	PEC	3	0	0	3	3
6.	MS3051	Human Resource Management	PEC	3	0	0	3	3
7.	MS3003	Modern Techniques of Materials Characterization	PEC	3	0	0	3	3
8.	MS3004	Sustainable and Green Manufacturing	PEC	3	0	0	3	3
9.	PD3151	Integrated Product Design and Development	PEC	3	0	0	3	3
10.	MS3005	Financial Management and Accounting	PEC	3	0	0	3	3
11.	ED3052	Material Handling Systems and Design	PEC	3	0	0	3	3
12.	MS3006	Materials Management	PEC	3	0	0	3	3

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	RM3151	Research Methodology and IPR	2	1	0	3	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

Sl. No	COURSE CODE	Course Title	Periods per week			Credits	Semester
			Lecture	Tutorial	Practical		
1	MS3112	Technical Seminar	0	0	4	2	1
2	MS3212	Industrial Training/ Internship	0	0	0	2	2
3	MS3311	Project Work I	0	0	12	6	3
4	MS3411	Project Work II	0	0	24	12	4

SUMMARY

	Name of the Programme					
	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL
		I	II	III	IV	
1.	FC	3				3
2.	PCC	11	16			27
3.	PEC	3	6	9		18
4.	RMC	3				3
5.	EEC	2	2	6	12	22
6.	**TOTAL CREDIT**	**22**	**24**	**15**	**12**	**73**

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MS3101	STATISTICAL QUALITY CONTROL FOR MANUFACTURING SYSTEMS	L	T	P	C
		2	1	0	3

COURSE OBJECTIVES:

The objective of this course is to impart knowledge on quality concepts, control charts for variables & attributes, process capability and acceptance sampling**.**

UNIT I INTRODUCTION 9

Definition of quality, Dimensions of quality, quality Engineering Terminology, Quality control, objectives of quality control, Quality costs, Quality of Design, Quality of conformance, quality planning, quality measurement, troubleshooting, diagnostic techniques.

Sampling theory – Population, sample, influence of sample size – Estimation of population parameter from samples – Mean, variance, differences of means, ratios of variances. Test of Hypothesis-Null and Alternate Hypothesis, Level of Significance, One tail and two tailed tests, Test of Hypothesis of mean, variance, and ratios of variances, Probability Distribution

UNIT II CONTROL CHART FOR VARIABLES 9

Variation in process – causes for variation – Factors control charts, X bar -R Chart, X bar – σ Chart, MR Chart – Tolerance design – Interpreting control charts – pattern study – Six Sigma Management: Concepts, Steps and Tools ; Benchmarking and Balanced Score Cards

UNIT III CONTROL CHART FOR ATTRIBUTES 9

Control chart for attributes – Control chart for proportion or fraction defectives – p chart and np chart – control chart for defects – c and u charts, quality rating – Demerit chart – State of control and process out of control identification in charts.

UNIT IV SPECIAL CONTROL CHART AND PROCESS CAPABILITY 9

Cumulative sum (CUSUM) control charts- V mask procedure- Control chart for Multiple stream process- Group control charts- Tool wear control chart. Process capability studies: Natural tolerance limits, Process capability analysis using histogram, probability plot and control chart. Process capability ratios, Process capability analysis of normal and non-normal distributions. Process capability analysis using Designed experiments and Attribute data - Gauge and Measurement system capability studies.

UNIT V ACCEPTANCE SAMPLING 9

Lot by lot sampling – Types of sampling plans– Probability of acceptance in single, double, multiple sampling plans– OC curves – Producer's risk and consumer's risk – AQL, LTPD, AOQL, Concepts – Design of sampling plans – Standard sampling plans for AQL and LTPD – Use of standard sampling plans, sequential sampling plan.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Apply statistical techniques for quality control
CO2: Analyze control chart for variables
CO3: Analyze control chart for attributes
CO4: Summarize the process capability
CO5: Discuss the acceptance sampling

REFERENCES:

1. Amitava Mitra “Fundamentals of Quality Control and improvement” Wiley, 2008.
2. Douglas.C. Montgomery, “Introduction to Statistical quality control”, 7th edition, John Wiley 2012.
3. Douglas.C. Montgomery, “Applied statistics and Probability for Engineers”, Wiley 2018.
4. Edwards Staple Smith, “Control charts- Introduction to Statistical Quality control” McGraw Hill 2013
5. Grant, Eugene. L “Statistical Quality Control”, TMH, 2005
6. John.S. Oakland. “Statistical process control”, Elsevier Butterworth-Heinemann, 2008
7. Jeya Chandra M, “Statistical Quality Control”, CRC press, 2001
8. Principle of Quality Control: By Jery Banks, John Wiley.

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	2	2	2			2
2		2	2	2	1	
3		2	2	2		
4	1	2	2			1
5		2	2	2		
Avg.	1.5	2	2	2	1	1.5

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MS3102 MANUFACTURING MANAGEMENT L T P C

3 0 0 3

COURSE OBJECTIVES:

To provide the knowledge on Manufacturing function, forecasting, Planning the project, facility and Production, Inventory control and Maintenance Management.

UNIT I PRODUCTION AND OPERATIONS MANAGEMENT 9

Manufacturing management – Scope and objective - Production systems – Classification - Production versus Services and productivity. Forecasting - components of demand, Quantitative and qualitative techniques- Single moving average method - Single exponential smoothing method - Simple linear regression models – Seasonal model – measurement of forecasting errors.

UNIT II PROJECT AND FACILITY PLANNING 9

Project Management –PERT, CPM, CPM networks – Simple Problems. Facility Location – Theories, Steps in Selection, Location Models – Simple Problems. Facility Layout – Principles, Types, Planning tools and techniques.

UNIT III 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 IV INVENTORY CONTROL 9

Introduction to EOQ models, Inventory control techniques – ABC, FSN, VED etc. Types of inventory control – Perpetual, two-bin and periodic inventory system – Determination of ROL, Safety Stocks –Service level - Methods of calculating safety stock using Normal distribution. JIT, SMED, Kanban, zero inventory.

UNIT V MAINTENANCE MANAGEMENT 9

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:

Upon the completion of this course the student will be able to

CO1: Describe the production system and perform demand forecasting.
CO2: Analyze effectively the facility location and manage the projects
CO3: Choose the strategies of Production planning and operations scheduling.
CO4: Select appropriate inventory technique and determine safety stocks.
CO5: Compare the different maintenance and replacement strategies.

REFERENCES:

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.
4. KanishkaBedi, “Production and Operations Management”, 2nd Edition, Oxford Higher Education, 2007
5. Lee. J. Krajewski, L. P. Ritzman, & M. K. Malhothra, “Operations Management –

Process and Value Chains", 8th Edition, PHI/Pearson Education, 2007.
6. Melnyk Denzler, "Operations Management – A Value Driven Approach", Irwin McGraw Hill1996.
7. 7. Pannererselvam, R "Production and Operations Management", 3rd Edition, PHI, 2012.

CO	PO					
	1	2	3	4	5	6
1	1		3	1	3	
2	2		3	2	3	1
3			3		3	2
4	1		3	2	3	1
5			3		3	
Avg.	2		3	1.67	3	1.33

MS3103	DIGITAL MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

This course aims to impart knowledge on the basics elements and technologies required to realize intelligence in the manufacturing industry.

UNIT I INTRODUCTION TO DIGITAL MANUFACTURING 9

Engineering and Organizational Science in manufacturing, multi-crossed disciplines in manufacturing, Definition of digital manufacturing (DM), DM idea taking - Control for center, Design for center, Management as its center, Features and development of DM, Operation mode and architecture of DM system, Models of DM System – Organizational model, Function model, Information model, Operation and control model, Modelling theories of DM.

UNIT II INTELLIGENT MANUFACTURING 9

Intelligent Multi Information Sensing – Application of Sensors in processing, Sensors in tool condition monitoring; Intelligent multi information system, Fusion in the Manufacturing Process, Application of Multi-Sensor Fusion in Tool State Monitoring, Data mining - Methods, Applied to DM; Knowledge Engineering, Intelligent Knowledge-Based Manufacturing System, Autonomy, Self-Learning, Adapting of Manufacturing System, Concepts and features of Intelligent manufacturing system, Multi agent manufacturing system, Holonic Manufacturing System

UNIT III TECHNOLOGY OF DIGITAL MANUFACTURING 9

Various Digital Technologies in Product Lifecycle, Digital Equipment Technology, Digital Processing technology, Digital Maintenance, Digital logistic technology, Resource and environment technology in Digital Manufacture - Resource organization and management Technology, Manufacturing grid; Resource Service and Security Technology, Digital management system in DM, Control Technology in DM, Digital Recognition and Integration Technology - Radio-Frequency Identification Technology, Bar Code Recognition Technology; Electromechanical Integration Technology.

UNIT IV ADDITIVE MANUFACTURING 9

Definition and terminologies, Industry drivers for additive manufacturing adaption, Additive manufacturing process chain, Additive manufacturing technologies and processes – Vat photo polymerization, Material extrusion, Material jetting, sheet lamination, powder bed fusion, binder jetting, direct energy deposition; Materials, Printability in 3D printing, Post processing, Applications.

UNIT V DIGITAL TWIN(DT), VIRTUAL REALITY(VR) AND AUGUMENTED REALITY(AR) 9

Background, development and concepts of Digital Twin, Applications of DT, Functional requirements of DT - Data Availability, Architecture, Challenges of DT applications, Comparison of VR and AR, AR & VR in design, manufacturing and service, Applications of AR and VR in DT, Digital Twin-driven Assembly Combining VR and AR, Industrial Internet of Things (IIoT).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course the student will be able to

CO1: Differentiate the concepts and models of digital manufacturing.
CO2: Appraise the various technologies that realize intelligence in manufacturing.
CO3: Discuss the various technologies involved in digital manufacturing.
CO4: Explain the operating principles, capabilities and limitations of various additive manufacturing processes.
CO5: Describe the concepts and role of Digital Twin, Virtual Reality and Augmented Reality in digital manufacturing.

REFERENCES:

1. Zhou, Z., Xie, S., & Chen, D, “Fundamentals of digital manufacturing science”, London, UK:: Springer, 2012.
2. Bi, Zhuming., “Practical Guide to Digital Manufacturing: First-Time-Right for Design of Products, Machines, Processes and System Integration”, Springer Nature, 2021.
3. Ustundag, Alp, Emre Cevikcan., “Industry 4.0: managing the digital transformation”, Springer Nature, 2018.
4. Chandrakant D. Patel, Chun-Hsien Chenm, “Digital Manufacturing: The Industrialization of "Art to Part" 3D Additive Printing”, Elsevier Science, Netherlands, 2022.
5. Chaudhary, Gopal, Manju Khari, and Mohamed Elhoseny, “Digital Twin Technology”, CRC Press, 2021.

CO	PO					
	1	2	3	4	5	6
1	2		2	3	1	3
2	3		3	3	2	3
3	3		3	3	2	3
4	3		3	3	2	3
5	3		3	3	2	3
Avg.	3		2.8	3	1.8	3

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MS3104	LOGISTICS AND SUPPLY CHAIN MANAGEMENT FOR MANUFACTURING SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES: To understand and apply the principles and concepts in logistics and supply chain in manufacturing systems and its management.

UNIT I INTRODUCTION 9

Role of Logistics and Supply chain Management: Scope and Importance- Evolution of Supply Chain – Decision Phases in Supply Chain – Competitive and Supply chain Strategies – Drivers of Supply Chain Performance and Obstacles.

UNIT II SUPPLY CHAIN NETWORK DESIGN 9

Role of Distribution in Supply Chain – Factors influencing Distribution network design – Design options for Distribution Network Distribution Network in Practice-Role of network Design in Supply Chain – Framework for network Decisions.

UNIT III LOGISTICS IN SUPPLY CHAIN 9

Role of transportation in supply chain – factors affecting transportations decision – Design option for transportation network – Tailored transportation – Routing and scheduling in transportation.

UNIT IV SOURCING AND COORDINATION IN SUPPLY CHAIN 9

Role of sourcing supply chain supplier: selection assessment and contracts – Design collaboration – Sourcing planning and analysis – Supply chain co-ordination – Bull whip effect – Effect of lack of co-ordination in supply chain and obstacles – Building strategic partnerships and trust within a supply chain.

UNIT V SUPPLY CHAIN AND INFORMATION TECHNOLOGY 9

The role IT in supply chain – The supply chain IT frame work – Customer Relationship Management – Internal supply chain management – Supplier relationship management – EBusiness in supply chain – Future of IT in supply chain (IoT)

TOTAL: 45 PERIODS

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

CO1: Apply the role of logistics & supply chain in manufacturing systems.
CO2: Apply the network design concepts in supply chain for manufacturing systems.
CO3: Apply the principles of logistics in supply chain for manufacturing systems.
CO4: Apply the principles of sourcing and coordination in supply chain for manufacturing systems.
CO5: Apply the principles of information technology in supply chain for manufacturing systems.

REFERENCES:

1. Sunil Chopra, Peter Meindl and Kalra, “Supply Chain Management, Strategy, Planning, and Operation”, Pearson Education, 2010.
2. Jeremy F.Shapiro, “Modeling the Supply Chain”, Thomson Duxbury, 2002.
3. Srinivasan G.S, “Quantitative models in Operations and Supply Chain Management, PHI, 2010
4. David J.Bloomberg , Stephen Lemay and Joe B.Hanna, “Logistics”, PHI 2002.
5. James B.Ayers, “Handbook of Supply Chain Management”, St.Lucle press, 2000.

CO	PO					
	1	2	3	4	5	6
1	3	3	3	2	2	3
2	3	3	3	2	2	3
3	3	3	3	2	2	3
4	3	3	3	2	2	3
5	3	3	3	2	2	3
Avg.	3	3	3	2	2	3

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RM3151 RESEARCH METHODOLOGY AND IPR L T P C
2 1 0 3

OBJECTIVES:

To impart knowledge on

- Formulation of research problems, design of experiment, collection of data, interpretation and presentation of result
- Intellectual property rights, patenting and licensing

UNIT I RESEARCH PROBLEM FORMULATION 9

Objectives of research, types of research, research process, approaches to research; conducting literature review- information sources, information retrieval, tools for identifying literature, Indexing and abstracting services, Citation indexes, summarizing the review, critical review, identifying research gap, conceptualizing and hypothesizing the research gap

UNIT II RESEARCH DESIGN AND DATA COLLECTION 9

Statistical design of experiments- types and principles; data types & classification; data collection - methods and tools

UNIT III DATA ANALYSIS, INTERPRETATION AND REPORTING 9

Sampling, sampling error, measures of central tendency and variation,; test of hypothesis- concepts; data presentation- types of tables and illustrations; guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript; guidelines for writing thesis, research proposal; References – Styles and methods, Citation and listing system of documents; plagiarism, ethical considerations in research

UNIT IV INTELLECTUAL PROPERTY RIGHTS 9

Concept of IPR, types of IPR – Patent, Designs, Trademarks and Trade secrets, Geographical indications, Copy rights, applicability of these IPR; , IPR & biodiversity; IPR development process, role of WIPO and WTO in IPR establishments, common rules of IPR practices, types and features of IPR agreement, functions of UNESCO in IPR maintenance.

UNIT V PATENTS 9

Patents – objectives and benefits of patent, concept, features of patent, inventive steps, specifications, types of patent application; patenting process - patent filling, examination of patent, grant of patent, revocation; equitable assignments; Licenses, licensing of patents; patent agents, registration of patent agents.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of the course, the student can

CO1: Describe different types of research; identify, review and define the research problem

CO2: Select suitable design of experiment s; describe types of data and the tools for collection of data

CO3: Explain the process of data analysis; interpret and present the result in suitable form

CO4: Explain about Intellectual property rights, types and procedures

CO5: Execute patent filing and licensing

REFERENCES:

1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).
2. Soumitro Banerjee, “Research methodology for natural sciences”, IISc Press, Kolkata, 2022,
3. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
4. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.
5. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.

MS3111 **MANUFACTURING SYSTEMS LABORATORY** **L T P C**
0 0 4 2

Course Objectives:
To get hands on experience of the various quality control aspects including incoming product inspection and in-process inspection involved in a manufacturing organization.

S. No.	LIST OF EXPERIMENTS
1	Performing quality checks on given raw materials (hardness, tensile strength, etc.)
2	Interpretation of dimensional and geometric tolerances in the given component drawing and prepare process plans to manufacture the component.
3	Manufacturing the component according to the prepared process plan by selecting appropriate process parameters
4	Measurement of typical dimensional parameters in a machined component
5	Measurement of typical GD&T parameters in a Machined component
6	Measurement of Surface roughness in components manufactured using various processes (turning, milling, grinding, etc.,) using stylus based instruments
7	Surface defect inspection and reverse engineering using 3D digitalisation with 3D scanner
8	Measurement system analysis for a typical measurement system using Gage R&R study
9	Use I4.0 data management software to record quality conformance data
10	Process capability studies for the a given machining process
11	Machine tool Metrology – Geometrical / Alignment tests on lathes and milling machines
12	Condition based monitoring of machine tools using AE sensors and vibration measurement during machining

TOTAL: 60 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

CO1: Interpret engineering drawings and prepare process plans to manufacture simple components.

CO2: Select a suitable measuring instrument for measurement of linear, angular and geometric dimensions and use the same for carrying out measurements in the given component.

CO3: Carryout measurement system analysis and measure the process capability of machine tools through accuracy tests and condition-based monitoring.

CO	PO					
	1	2	3	4	5	6
1	3	3	3		2	2
2	3	2	3		2	2
3	3	3	3	2	3	3
Avg.	3	2.7	3	2	2.3	2.3

MS3201	LEAN MANUFACTURING SYSTEMS AND SIX SIGMA	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main objective of the course is to impart knowledge of the various tools and techniques involved in lean manufacturing and the DMAIC methodology of six sigma.

UNIT I EVOLUTION OF LEAN PRODUCTION 9

Evolution of Mass production, Traditional versus Mass production, Evolution of Toyota (Lean) Production System, Business Dynamics of Lean production, Principles of Lean production – Value, Value stream, Flow, Pull, Perfection

UNIT II TECHNIQUES OF LEAN PRODUCTION 9

3Ms – Muda, Mura, Muri, 7 Wastes in Manufacturing, Lean Tools to eliminate Muda - 5S, Standardised work, TPM, SMED, Jidoka – Poka Yoke, JIT, Heijunka, Kanban.

UNIT III VALUE STREAM MAPPING 9

Need for Value Stream mapping; Steps involved in Value stream mapping – Identifying the value stream – PQ and PR analysis, VSM Icons, Timelines, product, information and communication flow, Current State map, Lean Metrics, Future State Map - FIFO lanes, load levelling and Kaizen bursts, Kaizen plans; Lean implementation - Percentage plan complete - Cultural change, Hoshin planning; Lean in the Supply chain.

UNIT IV SIX SIGMA FOR QUALITY IMPROVEMENT 9

Statistical theory, Need for Six Sigma, Six Sigma Team, DMAIC Methodology – Various quality tools used in the Define, Measure, Analyse, Improve and Control phases - control plans, Reinforcing new behaviour and organizational change.

UNIT V LEAN SIX SIGMA 9

Lean Six Sigma essentials, Design for lean six sigma - Quality Function Deployment, Theory of Inventive Problem Solving, Failure Mode Effect Analysis, Implementing lean designs, Case studies of lean six sigma in manufacturing, healthcare, and office.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Explain the importance and evolution of mass production and lean principles.
CO2: Apply the various tools, techniques and methodology of lean manufacturing to improve the efficiency of an organization.
CO3: Apply the technique of value stream mapping to improve an organization by drawing current and future state maps.
CO4: Apply six sigma methodology to improve quality in a manufacturing organisation.
CO5: Explain the process of institutionalizing the LSS effort and also understand the Design for LSS.

REFERENCES:

1. Pascal Dennis, “Lean production Simplified: A plain language guide to the world’s most powerful Production system”, Productivity Press 2007
2. Michael L. George, Lean Six Sigma: Combining Six Sigma Quality with Lean Production Speed, McGraw-Hill, 2002.
3. Issa Bass and Barbara Lawton, “Lean Six Sigma using Sigma XL and Minitab”, Tata McGraw Hill 2010.
4. Askin R G and Goldberg J B, “Design and Analysis of Lean Production Systems”, John Wiley and Sons Inc., 2003.

5. Donna C. S. Summers, “Six sigma: Basic tools and techniques”, Pearson / Prentice Hall 2007.
6. James Womack and Daniel T. Jones, “Lean Thinking: Banish waste and create wealth in your organization”, Free Press 2003.
7. Mike Rother and Rother Shook, “Learning to See: Value-Stream Mapping to Create Value and Eliminate” Muda, The Lean Enterprise Institute 2003
8. Mark A. Nash and Sheila R. Poling, “Mapping the total value stream: A Comprehensive Guide for Production and Transactional Processes”, CRC Press, New York, 2008.

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	1	2	1		2	1
2	3	1	3	1	3	3
3	3	1	3	3	3	3
4	3	1	3	3	3	3
5	2	2	2	2	3	3
Avg.	2.4	1.4	2.4	2.25	2.8	2.6

MS3202	ENTERPRISE RESOURCE PLANNING FOR MANUFACTURING SYSTEMS	L	T	P	C
		3	0	4	5

COURSE OBJECTIVES:

The main objective of the course is to impart knowledge and hands on experience on the ERP and their requirements, planning, design and implementation of ERP systems.

UNIT I INTRODUCTION TO ERP 9

Need for an ERP, The Evolution of ERP, Conceptual framework of ERP, Benefits of ERP, ERP Modules – Finance module, Human Resource Management Module, Sales and Distribution Module, Business process reengineering.

UNIT II ERP ARCHITECTURE AND SYSTEM PACKAGES 9

Client/Server architecture, Technology choices, Internet direction, Evaluation framework, CRM, CRM pricing, Chain safety, Evaluation framework.
ERP Packages, Comparison, Integration of different ERP applications

UNIT III PLANNING, DESIGN AND IMPLEMENTATION OF ERP SYSTEMS 9

Traditional and New approaches to systems development, The ERP Systems development process, ERP life cycle, Methods for SAP implementation and steps, Different ERP implementation strategies, Implementation cost, Customizing

UNIT IV ERP SYSTEMS FOR PRODUCTION AND MATERIALS MANAGEMENT 9

ERP Systems – Production Planning module, Manufacturing module, Materials Management module, Manufacturing Execution systems and ERP, Production data acquisition – PDA, MDA, TDA, Engineering information systems, Product data Management.

UNIT V CURRENT AND FUTURE TRENDS IN ERP 9

Service oriented Architecture, On demand solutions – Software as a service and cloud computing, ERP on demand, Open-source ERP, The Internet of Things – Background and Technology, RFID applications, Benefits and challenges.

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS

1. Customer relationship management
2. Sales order management
3. Materials Resource planning
4. Supply chain management
5. Finance and accounting
6. Planning and Scheduling
7. Inventory management
8. Warehouse management
9. Job and Process costing
10. Real time Production monitoring
11. Real time Process monitoring
12. Quality management
13. Shipping and distribution

COURSE OUTCOMES

CO1: Explain the need and importance of ERP and its modules.
CO2: Compare the Various architectures of ERP system packages.
CO3: Demonstrate the various phases involved in planning, design and implementation of ERP systems.
CO4: Describe the use of ERP for production and materials management.
CO5: Explain the current and future status of ERP in industries.
CO6: Apply ERP modules for master data creation, inventory data, sales order processing, invoice generation, production and process monitoring and logistics management

REFERENCES:

1. Ray R., "Enterprise Resource Planning: A Text and Cases", India, 2010, Tata McGraw Hill Education Private Limited.
2. Kurbel Karl E., "Enterprise Resource Planning and Supply Chain Management: Functions, Business Processes and Software for Manufacturing Companies", Germany, 2013, Springer Berlin Heidelberg.
3. Monk, E., Wagner B., "Concepts in Enterprise Resource Planning", United States, 2012, Cengage Learning.
4. Sumner, Mary. "Enterprise Resource Planning", India, 2006, Pearson Education.
5. Anbuudayasankar S. P., Ganesh K., Sivakumar P., Mohapatra S. "Enterprise Resource Planning: Fundamentals of Design and Implementation", Germany, 2014, Springer International Publishing.

CO	PO					
	1	2	3	4	5	6
1	2	1	2	2	2	2
2	3	1	3	3	2	1
3	3	1	3	3	2	1
4	3	1	3	3	2	1
5	2	1	2	2	2	3
6	3	2	3	2	3	2
Avg.	2.67	1.17	2.67	2.50	2.17	1.67

MS3203	EXPERIMENTAL DESIGN AND ANALYSIS	L	T	P	C
		2	1	0	3

COURSE OBJECTIVES: To understand and apply the principles, concepts and techniques in experimental design for manufacturing systems and its management.

UNIT I INTRODUCTION & BASIC STATISTICAL CONCEPTS **9**

Strategy of Experimentation, Typical applications of Experimental design, Basic Principles, Guidelines for Designing Experiments. - Concepts of random variable, probability, density function cumulative distribution function. Sample and population, Measure of Central tendency; Mean median and mode, Measures of Variability, Concept of confidence level. Statistical Distributions: Normal, Log Normal & Weibull distributions. Hypothesis testing, Probability plots, choice of sample size. Illustration through Numerical examples.

UNIT II EXPERIMENTAL DESIGN **9**

Classical Experiments: Factorial Experiments: Terminology: factors, levels, interactions, treatment combination, randomization, Two-level experimental designs for two factors and three factors. Three-level experimental designs for two factors and three factors, Factor effects, Factor interactions, Fractional factorial design, Saturated Designs, Central composite designs. Illustration through Numerical examples.

UNIT III ANALYSIS AND INTERPRETATION METHODS **9**

Measures of variability, Ranking method, Column effect method & Plotting method, Analysis of variance (ANOVA) in Factorial Experiments: YATE's algorithm for ANOVA, Regression analysis, Mathematical models from experimental data. Illustration through Numerical examples.

UNIT IV QUALITY BY EXPERIMENTAL DESIGN & ORTHOGONAL ARRAYS **9**

Quality, Western and Taguchi's quality philosophy, elements of cost, Noise factors causes of variation. Quadratic loss function & variations of quadratic loss function. Robust Design: Steps in Robust Design: Parameter design and Tolerance Design. Reliability Improvement through experiments, Illustration through Numerical examples. Types of Orthogonal Arrays, selection of standard orthogonal arrays, Linear graphs and Interaction assignment, Dummy level Technique, Compound factor method, Modification of linear graphs. Illustration through Numerical examples.

UNIT V SIGNAL TO NOISE RATIO & PARAMETER AND TOLERANCE DESIGN **9**

Evaluation of sensitivity to noise. Signal to Noise ratios for static problems: Smaller-the-better type, Nominal-the –better-type, Larger-the-better type. Signal to Noise ratios for Dynamic problems. Illustration through Numerical examples. Parameter and tolerance design concepts, Taguchi's inner and outer arrays, parameter design strategy, tolerance design strategy. Illustration through Numerical examples.

TOTAL: 45 PERIODS

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

CO1: Apply the statistical concepts in experimental design.
CO2: Apply the experimental design concepts for manufacturing systems.
CO3: Apply the principles of analysis and interpretation methods in experimental design for manufacturing systems.
CO4: Apply the concepts of quality and orthogonal array in experimental design for manufacturing systems.
CO5: Apply the concepts of SN ratio, parameter & tolerance design in experimental design for manufacturing systems.

REFERENCES:

1. Montgomery, D.C., “Design and Analysis of Experiments”, John Wiley & Sons, 2010.
2. Dean, A. M., & Voss, D. T., “Design and Analysis of Experiments”, Springer, 1999.
3. Krishnaiah, K. & Shahabudeen, P., “Applied Design of Experiments & Taguchi Methods”, PHI, 2012.
4. Mason, R. L., Gunst, R. F., & Hess, J. L., “Design and Analysis of Experiments: with Applications to Engineering & Science”, Wiley Series on Probability & Statistics, John Wiley & Sons, 2003.
5. Panneerselvam. R, “Design & Analysis of Experiments”, PHI, 2012.

CO	PO					
	1	2	3	4	5	6
1	3	3	3	3	3	2
2	3	3	3	3	3	2
3	3	3	3	3	3	2
4	3	3	3	3	3	2
5	3	3	3	3	3	2
Avg.	3	3	3	3	3	2

Attested

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MS3204	MAINTENANCE AND RELIABILITY ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

To impart knowledge on Maintenace & reliablity concepts, strategies and its management

UNIT – I MAINTENANCE CONCEPTS 9

Maintenance: Definition, Systems approach, Objectives, Requirements, Levels, Maintenance policies and procedures, Maintenance principles and benefits. Types of maintenance systems, R&D in maintenance, Role of overhauling in maintenance, Expert systems in maintenance and Maintenance evaluation and its types.

UNIT – II MAINTENANCE STRATEGIES 9

Preventive maintenance: Needs, Elements, Steps, Measures and benefits. Corrective maintenance: Types, Steps, measures and benefits. Reliability Centered Maintenance (RCM): Goals and principles, Process, Components Measures and Advantages. Condition based Maintenance: Condition Monitoring Techniques, Systems approach, Applications and benefits. Total Productive Maintenance: Methodology and implementation.

UNIT – III MAINTENANCE MANAGEMENT 9

Organisation structure for management: Objectives, Functions and Requirements, Types of organization and cost minimization. Maintenance planning: Manpower allocation, Planning Techniques & Procedure and maintenance scheduling. Spare parts management: Conventional system, EOQ, Two-bin system and Materials management manual. Economic aspects of Maintenance: Life cycle costing, Maintenance cost, Budget and Audit.

UNIT – IV RELIABILITY CONCEPTS 9

Definition of reliability , Performance and reliability, Reliability requirements, System life cycle , Mean time between failures , Mean time to failure , Mortality Curve, Availability, Maintainability, Bathtub curve, Time dependent failure models, Normal, Weibull and Lognormal distributions.

UNIT – V RELIABILITY PREDICTION & MANAGEMENT 9

Reliability of system: Serial, parallel and combined configuration, standby systems, Design for reliability- Product life cycle, Reliability tools and techniques: Top- down and Bottom-up techniques. Reliability testing: Accelerated life testing, Reliability enhancement testing & Environment stress screening and Reliability growth planning.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Identify the maintenance requirements, policies & procedures and apply them in a given situation.
- **CO2:** Classify the various maintenance strategies and implement it based on the industrial need.
- **CO3:** Plan the work force, schedule and manage the spares.
- **CO4:** Explain the reliability concepts and identify the data requirements
- **CO5:** Analyze the reliabilty system and categorize the reliability tools, testing and planning.

REFERENCES:

1. Mishra R C, “Reliability and Maintenance Engineering”, New Age International, 2006.
2. Charles E. Ebling., “An Introduction to Reliability and Maintability Engineering”, Tata McGraw Hill, 2004.

3. Venkataraman V, “ Maintenance Engineering and Management”, PHI learning, 2007
4. Dhillon B S, “Engineering Maintenance: A modern approach”, CRC press, 2002.
5. Mohamed Ben-Daya, Salih O. Duffuaa, Abdul Raouf, Jezdimir Knezevic, Daoud Ait-Kadi, “Handbook of Maintenance Management and Engineering”, Springer Science & Business Media, 2009.
6. Srinath L S, “Reliability Engineering”, Affiliated East West Press, 1991.
7. Connor, P. D. T. O., “Practical Reliability Engineering”, John Wiley, 1997.

CO	PO					
	1	2	3	4	5	6
1			3		3	
2			3		3	1
3			3	1	3	2
4	1		3	2	3	
5	2		3	3	3	
Avg.	1.5		3	2	3	1.5

MS3211 **MANUFACTURING ANALYTICS LABORATORY** **L T P C**

0 0 4 2

Course Objectives:

The main objective of the course is provide hands on experience in using software tools to solve problems in operations research and for quality control in lean manufacturing and six sigma.

1. Graphical representation of data using statistical software - 7 basic QC tools
2. Drawing current state and future state value stream map using software tools
3. Solving problems in experimental design
    a. Regression
    b. ANOVA
    c. Taguchi's experimental design
    d. Response surface methodology
    e. Grey Relational Analysis
    f. TOPSIS
4. Multi-objective optimization algorithm - Simulated Annealing
5. Predictive analytics for improvement of manufacturing process quality in common machining processes – turning, milling, drilling
6. Solving Linear programming problems
7. Solving Transportation Problems
8. Network flow analysis using - PERT, CPM
9. Inventory problems

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1: Use statistical software tools to solve problems in Operations Research and SQC

CO2: Analyse the performance of manufacturing organizations through lean tools / QC tools and improve their performance through data analytics and optimisation.

CO3: Solve problems in experimental design using statistical software tools.

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	3	2	3	3	3	3
2	3	3	3	3	3	3
3	3	2	3	2	3	3
Avg.	3	2.3	3	2.7	3	3

MS3052	PRODUCT DESIGN FOR MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES: To understand and apply the principles of economics in process selection and the design recommendations for casting, forming, machining, welding and assembly.

UNIT I INTRODUCTION AND CASTING 9

Introduction – Economics of process selection – General design principles for manufacturability;

Design considerations for: Sand cast parts – Permanent mold cast parts – Investment cast parts – Die cast parts.

UNIT II FORMING 9

Design considerations for: Metal extruded parts – Stamped parts – Cold headed parts – Forged parts.

UNIT III MACHINING 9

Design considerations for: Turned parts – Drilled parts – Milled parts - Planed, shaped and slotted parts– Broached parts – Cylindrically Ground parts (Center & Centerless).

UNIT IV WELDING 9

Arc welding – Design considerations for: Cost reduction – Minimizing distortion – Weld strength – Weldment & heat treatment. Resistance welding – Design considerations for: Spot – Seam. Soldering & Brazing: Design recommendations.

UNIT V ASSEMBLY 9

Design for assembly – Minimizing the no. of parts – Guidelines for assembly improvement – Design considerations for: Rivets – Screw fasteners – Automatic assembly. Case studies.

TOTAL: 45 HOURS

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

CO1: Apply the principles of economics in process selection. Apply the design recommendations for casting.
CO2: Apply the design recommendations for forming.
CO3: Apply the design recommendations for maching.
CO4: Apply the design recommendations for welding.
CO5: Apply the design recommendations for assembly.

REFERENCES:

1. James G. Bralla, “Handbook of Product Design for Manufacture”, McGraw Hill Book Co., 1986.
2. Henry Peck, “Designing for Manufacture”, Sir Isaac Pitman & Sons Ltd., 1973.
3. Matousek, “Engineering Design”, Blackie & Sons, 1956.
4. O. Molloy, E.A. Warman, S. Tilley, “Design for Manufacturing and Assembly Concepts, Architectures and Implementation”, Springer, 2012.
5. Ancuta Carmen Păcurar (Ed), “Applications of Design for Manufacturing and Assembly”, IntechOpen Publishers, 2019.

CO	PO					
	1	2	3	4	5	6
1	3	2	3	3	2	2
2	3	2	3	3	2	2
3	3	2	3	3	2	2
4	3	2	3	3	2	2
5	3	2	3	3	2	2
Avg.	3	2	3	3	2	2

Attested

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MN3052	MECHATRONICS IN MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students

1. To Understand and apply the principles of mechatronics in modern manufacturing
2. To Develop proficiency in selecting and integrating sensors, transducers, drives, and actuators for mechatronic systems
3. To Design and optimize manufacturing processes using mechatronic principles and techniques
4. To Gain practical skills in programming and interfacing microcontrollers for controlling mechatronic systems
5. To Analyze and evaluate the performance of mechatronic systems in manufacturing operations for continuous improvement

UNIT I INTRODUCTION TO MECHATRONICS IN MODERN MANUFACTURING 9

Introduction to Process Parameters in Conventional Manufacturing – Assembly – Inspection –Transportation - Introduction to basic elements of Mechatronics Systems- Entities in Modern Manufacturing - Mechanical, Fluid, Thermal, Electrical, Electronics, Communication, Control systems and Software Integration for Manufacturing - Classification of Manufacturing based on Mechatronics – CNC based Subtractive Manufacturing –Rapid Prototyping based Additive Manufacturing- Automated Assembly Stations – Modern Quality Inspection and Transportation Systems

UNIT II SENSORS AND TRANSDUCERS 9

Introduction – Performance Terminology – Resistive Transducers – Inductive Transducers -

Capacitance Transducers – Optical Sensors – Contact and Non-Contact Temperature Sensors – Eddy Current Sensor – Hall Effect Sensor – Piezo Electric Sensor - Ultrasonic Sensors – Proximity Sensors – Chemical and Gas Sensors - Signal Conditioning - Condition Monitoring

UNIT III DRIVES AND ACTUATORS 9

Role of Linear and Rotary Actuators - Electrical Actuators- Servo Concepts and Stepper Motors - Fluid Power – Piezo Actuators – Solenoids - Function of Drives - Mechanical Switching Devices – Solid State drives for various actuators

UNIT IV MICROPROCESSORS AND MICROCONTROLLERS 9

Requirement for Processor – Comparison of 8085 Microprocessor and 8051 Microcontrollers– 8051 Microcontrollers Architecture -Assembly Language Programming- Instruction Set, Addressing Modes, Basic Programming – Interfacing - Sensors, Keyboard, LED, LCD, A/D and D/A Converters, Actuators – Embedded Systems

UNIT V INTEGRATION OF MANUFACTURING SYSTEMS 9

Design Process - Stages of Design Process – Skeletal Structure and Block Diagram of CNC Based - Vertical Machining Centre, turning centre, Water Jet Machine, Electrical Discharge Machine, Serial Manipulator, hydraulic press, 3 D printers– Coordinate Measuring Machine –Automated conveyors - Extended Transportation System – Total Integration of Manufacturing Systems for Production Automation

TOTAL : 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, students should be able to

CO1 Recall and identify key concepts in mechatronics for modern manufacturing.

CO2 Describe the principles and relationships of mechatronic system elements in manufacturing processes.

CO3 Apply knowledge of sensors, transducers, drives, and actuators to design and troubleshoot mechatronic systems.

CO4 Analyze and evaluate the performance of mechatronic components for process optimization.

CO5 Design and integrate mechatronic systems for manufacturing automation.

REFERENCES:

1. Bolton .W.,"Mechatronics" ,Pearson Education Limited, 5th Edition, 2011.
2. Mazidi. M.A and Mazidi .M.J., MCkinlay.R.D, "The 8051 Microcontroller and Embedded
   Systems Using Assemblyand C", Pearson India, 2nd Edition, 2008.
3. Patranabis D., "Sensor and Actuators", Prentice Hall of India Pvt Ltd., 2nd edition 2005.
4. Vijayaraghavan G.K., BalasundaramM.S , Ramachandran K.P. , Mechatronics: IntegratedMechanical Electronic Systems, Willey, 2008.
5. John P. Bentley., "Principle of Measurement systems", Pearson Prentice Hall, Fourth edition,2005.
6. K. Ogata, "Modern Controls Engineering ", Prentice Hall of India Pvt. Ltd., New Delhi, 2005.

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	COs Average
CO1	2	1	1	1	-	1	1.2
CO2	2	1	2	1	1	1	1.3
CO3	2	1	2	1	1	2	1.5
CO4	2	1	2	1	1	2	1.5
CO5	2	1	2	1	1	2	1.5
POs Average	2.0	1.0	1.8	1.0	1.0	1.6	

1 – Slight, 2 – Moderate, 3 - Substantial

MS3001	OPERATION RESEARCH FOR MANUFACTURING SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES: To understand and apply the principles, concepts and methods in operation research for manufacturing systems and its management.

UNIT I INTRODUCTION TO OPERATIONS RESEARCH & LINEAR PROGRAMMING MODELS **9**

Operations Research: Definition – Scope – Application Fields – Linear Programming Model: Concept of Linear Programming Model – Product Mix Problem – Assumptions in Linear Programming – Properties of Linear Programming Solution – Development of LP Models – Graphical Method – Linear Programming Methods: Simplex Method – Big M Method – Dual Simplex Method – Two-phase Method.

UNIT II TRANSPORTATION PROBLEM, ASSIGNMENT PROBLEM & PRODUCTION SCHEDULING PROBLEM **9**

Transportation Problem: Mathematical Model – Types: Balanced & Unbalanced – Methods: Initial Basic Solutions – Northwest Corner Method – Least Cost Method – Penatlty (Vogel Approximation Method) – Optimized Solution – U-V (MODI) Method – Assignment Problem: Zero-One Programming Model – Types – Hungerian Method – Case Study with Branch-and-Bound Technique – Flow Shop Scheduling Problem: Johnson's Algorithm for n Jobs and 2 Machines Problem – Extension of Johnson's Algorithm for n Jobs and 3 Machines Problem – Case Study on Branch-and-Bound Method for n Jobs and m Machines.

UNIT III INVENTORY CONTROL **9**

Models of Inventory: Purchase Model with Instantaneous Replenishment and without Shortages – Manufacturing Model without Shortages – Purchase Model with Instantaneous Replenishment and with Shortages – Manufacturing Model with Shortages – Fixed Order Quantity System (Q System) – Periodic Review System (P System) – EOQ Model for Multi-item Joint Replenishment (Purchase & Manufacturing Models) – Determination of Stock Level of Perishable Items under Probabilistic Condition.

UNIT IV QUEUEING THEORY **9**

Terminologies of Queueing System - Empirical Queueing Models: (M/M/1) : (GD/∞/∞) Model; (M/M/C) : (GD/∞/∞) Model; (M/M/1) : (GD/N/∞) Model; (M/M/C) : (GD/N/∞) Model (C≤N); (M/M/C) : (GD/N/N) Model (C<N); (M/M/1) : (GD/N/N) Model (N>1) – Case Study on Simulation.

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

Project Management – Phases – Guidelines for Network Construction – Critical Path Method (CPM) – Project Evaluation and Review Technique (PERT) – Replacement Models: Types – Determination of Economic Life of Assets – Probabilistic Model for Complete Failure.

TOTAL:45 HOURS

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

CO1: Apply the methods in solving linear programming models.
CO2: Apply the methods in solving transportation, assignment, production scheduling problem.
CO3: Apply the methods in solving inventory problems.
CO4: Apply the methods in solving queueing problems.
CO5: Apply the methods in solving project management problem and replacement problems.

REFERENCES:

1. Hamdy A Taha, “Operations research an introduction”, 10th edition, PHI/Pearson education, 2017.
2. Pannerselvam R, “Operations research”, 2nd edition, PHI, 2009.
3. Ravindran, Phillips and Solberg, “Operations research principles and practice”, 2nd edition, Wiley India, 2007.
4. Sharma J K, “Operations research theory and applications”,5th edition, Macmillan India, 2013.
5. Premkumar Gupta and D.S.Hira, “Problems in Operations research”, S.Chand, 2009

CO	PO					
	1	2	3	4	5	6
1	3	3	3	3	2	2
2	3	3	3	3	2	2
3	3	3	3	3	2	2
4	3	3	3	3	2	2
5	3	3	3	3	2	2
Avg.	3	3	3	3	2	2

CI3151	SOLID FREEFORM MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To gain knowledge on evolution of Solid Freeform Manufacturing (SFM) and the importance of DfAM in improving the quality.
- To acquaint with various SFM Technologies and hybrid processes, along with their material science and applications in different fields.

UNIT I INTRODUCTION 9

Introduction to solid freeform manufacturing (SFM) - Need- SFM evolution, Distinction between SFM & CNC machining- Development of SFM systems — Hierarchical structure of SFM - SFM process chain — Classification. SFM Supply chain - Economics aspect: Strategic aspect- Operative aspect

UNIT II DESIGN FOR ADDITIVE MANUFACTURING (DfAM) 9

Concepts and Objectives- General Guidelines for DfAM - DfAM tools, Requirements of DfAM methods, - Additive Manufacturing (AM) Unique Capabilities –Design Consideration in AM- Part Consolidation – Computational tools for design analysis- Topology Optimization - Lightweight Structures – Generative design- DfAM for Part Quality Improvement - CAD Modeling - Model Reconstruction - Data Processing for AM - Data Formats: STL, AMF,PLY, VRML- Data Interfacing - Part Orientation - Support Structure Design and Support Structure Generation - Model Slicing - Tool Path Generation.

UNIT III VAT POLYMERIZATION, MATERIAL EXTRUSION & SHEET LAMINATION TECHNOLOGIES 9

Vat polymerization: Stereolithography Apparatus (SLA): Principles — Photo Polymerization of SL Resins - Pre Build Process — Part-Building and Post-Build Processes - Part Quality and Process Planning, Recoating Issues - Materials - Capabilities - Limitations and Applications. Digital Light Processing (DLP) - Materials - Process – Capabilities and Applications. Continuous Liquid Interface Production (CLIP)- Materials - Process - Capabilities and Applications. Material extrusion: Fused deposition Modeling (FDM): Working Principles - Process - Materials – Capabilities and Applications. Design Rules for FDM. Sheet lamination processes: Laminated Object Manufacturing (LOM): Working Principles - Process – Materials- Capabilities- Limitations and Applications. Ultrasonic Additive Manufacturing (UAM) - Process - Parameters –Capabilities- Applications. Case Studies.

UNIT IV POWDER BED FUSION, BINDER JETTING, MATERIAL JETTING & DIRECT ENERGY DEPOSITION TECHNOLOGIES 9

Powder Bed Fusion: Selective Laser Sintering (SLS): Principles - Process - Indirect and Direct SLS - Powder Structure -Materials - Surface Deviation and Accuracy – Capabilities- Applications. Multi-jet Fusion Principles – Processes - Materials — Capabilities and Applications. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Principles — Processes — Materials — Capabilities - Limitations and Applications. Binder Jetting: Three dimensional Printing (3DP): Principles - Process - Physics of 3DP - Process — Materials - Capabilities - Limitations - Applications. Material Jetting: Multi Jet Modelling (MJM) - Principles - Process - Materials - Capabilities and Application. Direct Energy Deposition: Laser Engineered Net Shaping (LENS): Processes- Materials- Capabilities - Limitations and Applications. Hybrid Additive Manufacturing – Need - Principles - Part Quality and Process Efficiency. Wire Arc Additive Manufacturing (WAAM) Processes- Materials- Capabilities - Limitations and Applications. Case Studies.

UNIT V MATERIALS AND APPLICATIONS OF SFM 9

Materials science for SFM - Multifunctional and graded materials in AM, Role of solidification rate, Evolution of non-equilibrium structure, microstructural studies, Structure property relationship. Application of SFM in Automotive-Aerospace-Bio Medical-Bio printing- Food Printing- Electronics printing — Rapid Tooling - Building printing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1: Explore the importance in the evolution of SFM/AM, proliferation into the various fields and its effects on supply chain

CO 2: Recognize the importance of DfAM in improving the quality of fabricated parts and understand the guidelines of DfAM

CO 3: Acquire knowledge on principles and applications of vat polymerization, material extrusion and sheet lamination processes with case studies.

CO 4: Acquire knowledge on principles of powder bed fusion, jetting, direct energy deposition and hybrid processes

CO 5: Understand the properties and characteristics of materials used in SFM/AM and explore the applications in various fields.

CO - PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	2	1	2	2
CO2	3	3	2	2	2	3
CO3	3	2	3	3	3	2
CO4	3	3	2	3	3	2
CO5	3	2	3	2	3	3

REFERENCES:

1. Ian Gibson, David W. Rosen and Brent Stucker, “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing” Springer - New York, USA, 3rd Edition, 2021. ISBN- 978- 3-030-56126-0.
2. Andreas Gebhardt and Jan-Steffen Hotter, “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications Munchen, Germany, 2016. ISBN: 978-1-56990-582-1.
3. A Practical Guide to Design for Additive Manufacturing, Diegel, Olaf, Axel Nordin, and Damien Motte, Springer, 2020.
4. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 1°t Edition, 2019 FL, USA. ISBN-9780429029721
5. Ben Redwood, Brian Garret, Filemon Schoffer, and Tony Fadel, “The 3D Printing Handbook: Technologies, Design and Applications”, 3D Hubs B.V., Netherland, 2017. ISBN-13: 978- 9082748505.
6. Milan Brandt., “Laser Additive Manufacturing 1st Edition Materials, Design, Technologies, and Applications”, Woodhead Publishing, UK, 2016. ISBN-9780081004333.

MS3002 ADVANCED MATERIALS AND PROCESSING L T P C

3 0 0 3

OBJECTIVES

The main objective of this course is to impart knowledge on advanced materials, processes and their applications.

UNIT-I ADVANCED METALLIC MATERIALS 9

Al Alloys-Al-Li Alloys- First, Second and Third Generation Al-Li alloys-Microstructure-Precipitates Characteristics-Melting and casting of Al-Li alloys-workability-weldability, Super alloys, Materials for High temperature applications, Shape memory alloys- Shape memory effects- NiTi, Ti alloys- Properties and applications-workability-weldability, Steels-micro alloyed steels-TRIP steel-Microstructure-Properties-Applications

UNIT-II NEAR NET SHAPE FORMING PROCESSES 9

Forming-Compressive forming- tensile forming- combined tensile and compressive forming-sheet forming-Recrystallisation and grain growth-fundamentals of plasticity- forming limit-superplasticity- superplastic forming- superplasticity of metals, ceramics and nanostructured materials, Additive forming.

UNIT-III ADVANCED CERAMIC MATERIALS AND THEIR APPLICATIONS 9

Introduction, properties and applications of – oxides, carbides, nitrides; Advanced ceramic products – ceramic fibers, glass ceramics, High temperature ceramic materials-Ceramics Sintering- Solid state sintering – driving force, effect of surface curvature and boundary defects, mechanism, stages of sintering. Liquid phase sintering – stages, kinetic and thermodynamic factors, phase diagram in liquid phase sintering. Grain growth – different grain growth process, control of grain growth, grain growth and pore evolution in a porous compact, interaction between pore and grain boundary.

UNIT-IV NANOSTRUCTURED MATERIALS 9

Classifications of nanostructured materials-nanoparticles preparation-Mechanical Milling-Mechanochemical synthesis-sol-gel technique-PVD,CVD-characteristics- CNT-BNT-processing- growth mechanism-applications, nanowire – growth mechanism- applications, nano fabrication.

UNIT-V COATING MATERIALS AND TECHNOLOGY 9

Different coating materials-TiN,TiAlN,TiCrN,TiNbN, DLC-Thin films- Superhard coatings-nanocomposite coatings- Mechanisms-Thermal stability- High Temperature coatings-Different coating techniques-Mechanism of thin film growth, nanolubricants, CNT-Based conductive nanocomposites.

TOTAL:45 PERIODS

COURSE OUTCOMES

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

CO 1: Select and use advanced metallic materials in the thrust areas of mechanical engineering

CO 2: Select suitable forming techniques, design the forming process for the production of industrial components.

CO 3: Identify and use appropriate ceramic materials for different applications

CO 4: Produce different nanostructured materials and understand the different processing routes for nanomaterials

CO 5: Identify suitable coating materials and process to develop coating for industrial components.

REFERENCES:

1 Kurt Lange, Handbook of Metal Forming, Society of Manufacturing Engineers, USA

2 F. Singer and S. Singer, Industrial Ceramics, Oxford and IBH Publishing Co., 1991.

3 Nanostructured Materials, G. Wilde (Ed.), in the Series Frontiers of Nanoscience (Series Editor R. E. Palmer) Elsevier, Oxford, U. K./ Amsterdam, The Netherlands, 2009, pp. 51 – 126, ISBN-13: 978-0-08-044965-4.

4 Aluminum-Lithium Alloys: Processing, Properties, and Applications, (Editors N. Eswara Prasad, Amol A. Gokhale and RJH Wanhill), Elsevier, 2013, ISBN-13: 978-0124016989.

CO	PO					
	1	2	3	4	5	6
1	3		2			3
2	3		2			3
3	3		2			3
4	3		2			3
5	3		2			3
Avg.	3		2			3

Attested

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MS3051 HUMAN RESOURCE MANAGEMENT

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

To introduce and explain the functions, recruitment, selection, and training methods of Human Resource Management, as well as to examine the ideas of remuneration, labour relations, employee security, and quality assurance in HRM.

UNIT I HUMAN RESOURCE FUNCTION 9

Human Resource (HR) management – Meaning and importance- Difference between personnel and HR management – Changing environments of HRM – Strategic human resource management – Use of HRM to create competitive advantage – Trends in HRM – Organization of HR department – Role of HR Managers. Strategic Management Process and Human Resource Management. Evolution and growth of Personnel Management in India. Human Resources Policies: Need, type and Scope.

UNIT II RECRUITMENT & SELECTION 9

Job analysis: Methods – Job specification and description – HR and the responsive organization – IT and computerized skill inventory – Computer-based job analysis: HR planning and forecasting – Building employee commitment – Recruitment and selection process – Promotion from within – Developing and using application forms – IT and recruiting on the internet – Employee testing & selection: Selection process, basic testing concepts, types of test and validation – Work samples & simulation, selection techniques, interview, common interviewing mistakes – Designing & conducting the effective interview, competency mapping, computer-aided interview – Evaluation of selection process. Functions of Human Resources Management from Procurement to Separation – Placement, Induction, Transfers, Promotions Disciplinary actions, Termination of services.

UNIT III TRAINING & DEVELOPMENT 9

Orienting the employees, training process, need for training, training techniques, special purpose training, training via the internet – Training evaluation – Developing Managers: Management development – Responsive managers - On-the-job and off-the-job development techniques – Using HR to build a responsive organization – Use of CD-ROMs – Key factor for success – Performance appraisal: Tools, feedback, appraisal interviews – Performance appraisal in practice – Career planning and development – Managing promotions and transfers. MBO as a method of appraisal, job evaluation, criteria for promotions and job enrichment.

UNIT IV COMPENSATION & MANAGING QUALITY 9

Establishing pay plans: Basics of compensation – Factors determining pay rate – Current trends in compensation – Job evaluation – Pricing managerial and professional jobs – Computerized job evaluation – How to create a Market-Competitive Pay Plan-Pay for performance and financial incentives: Money and motivation – Incentives for operations employees and executives – Organization-wide incentive plans – Practices in Indian organizations – Services benefits: Statutory benefits – Non-statutory (voluntary) benefits – Insurance benefits – Retirement benefits and other welfare measures to build employee commitment. Personal services and family-friendly benefits flexible benefits programs.

UNIT V LABOUR RELATIONS & EMPLOYEE SECURITY 9

Implications of labour legislations – Employee health – Auditing HR functions, Future of HRM function. Workplace health hazards: problems and remedies-occupational security and safety.

Total: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able

CO1: To obtain knowledge of the roles and functions of Human resource management.

CO2: To become familiar with the various techniques used in the recruitment and selection process**.**

CO3: To understand the concepts of training methods and development techniques.

CO4: To understand the concepts of compensation and benefits.

CO5: To recognize the various employee relations and security.

REFERENCES:

1. Biswajeet Pattanayak, “Human Resource Management”, 6th Edition, PHI, 2020.
2. David A. DeCenzo; Stephen P. Robbins; Susan L. Verhulst, “Fundamentals of human resource management”, 12th Edition, John Wiley & Sons, Inc., 2016.
3. Arthur Diane, “Recruiting, Interviewing, Selecting, and Orienting New Employees”, 6th Edition, Thomas Nelson, 2019.
4. Gary Dessler & Biju Varkkey, "Human Resource Management", 16th Edition, Pearson Education, 2020.
5. Julie Beardwell & Amanda Thompson, “Human Resource Management: A Contemporary Approach, 8th edition, Published by Pearson, 2017.
6. John Stredwick, “An Introduction to Human Resource Management”, Routledge / Taylor & Francis 2014.
7. Robert L. Mathis, John H. Jackson, Sean R. Valentine, Patricia Meglich, “Human Resource Management”, 12th Edition, Cengage Learning, 2016.

CO	PO					
	1	2	3	4	5	6
1	2	2			1	
2	3	2	2		2	
3	3	2	1	3		2
4	2	2				
5	3	3		2		
Avg	2.6	2.2	1.5	2.5	1.5	2

MS3003 MODERN TECHNIQUES OF MATERIALS CHARACTERIZATION L T P C
3 0 0 3

OBJECTIVES:

The main objective of the course is to impart knowledge on qualitative and quantitative techniques for materials characterization.

UNIT I METALLOGRAPHIC TECHNIQUES 9

Metallurgical microscope - principle, construction and working, metallographic specimen preparation - magnification, numerical aperture, resolving power, depth of focus, depth of field, lenses aberrations and their remedial measures, various illumination techniques-bright field , dark field, phase-contrast, polarization microscopy, interference microscopy, quantitative metallography – Image analysis- Basics of laser scanning confocal microscopy.

UNIT II PRINCIPLES OF X-RAY DIFFRACTION 9

X-ray generation, absorption edges, characteristic spectrum, Crystallography basics, Bragg's law, Diffractometer- Stereographic projection. indexing- Intensity of diffracted beams – structure factor - other factors- Line broadening- crystallite size.

UNIT III ANALYSIS OF X-RAY DIFFRACTION 9

Precise lattice parameter evaluation, Determination of crystal structure - Phase identification, phase quantification, Phase diagram construction, - Determination of residual stress.

UNIT IV ELECTRON MICROSCOPY 9

Basic principles and applications of Transmission Electron Microscope – Selected Area Electron Diffraction and image formation, Sources of contrast- specimen preparation- Construction, modes of operation and application of Scanning Electron Microscope, Electron Backscattered Diffraction(EBSD) - Introduction to Scanning Tunnelling Microscope (STM) and Atomic Force Microscope (AFM).

UNIT V CHEMICAL AND THERMAL ANALYSIS 9

X-ray Fluorescence: Energy Dispersive Spectroscopy (EDS) and Wave Dispersive X-ray Spectrometry (WDS). Basic principles and applications of Auger spectroscopy, X- ray photoelectron spectroscopy (XPS).U-V, Visible, IR, FTIR and Raman spectroscopy – fluorescence and phosphorescence methods –flame photometry – atomic absorption – Inductively Coupled Plasma -Atomic Emission Spectrometry (ICP- AES). Basic principles and applications of Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC) and Thermo Gravimetric Analysis (TGA).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able:

CO1: To explain the principles of various Metallography techniques to reveal microstructure details.

CO2: To describe basics of X-ray diffraction and reasons behind variation in intensity of XRD peaks.

CO3: To apply methodology to determine crystal structure, lattice parameter, residual stress and quantitative phase estimation.

CO4: To elaborate instrumentation of Electron Microscopy and sources of image contrast.

CO5: To state the technique of chemical analysis for composition determination and application of thermal analysis.

REFERENCES:

1. Cullity, B. D., “Elements of X-ray Diffraction”, Addison-Wesley Company Inc., New York, 3rdEdition, 2000.
2. D. A. Skoog, F. James Leary and T. A. Nieman, "Principles of Instrumental Analysis", 5thEdition, Saunders Publishing Co., 1998.
3. Sam Zhang, Lin Li, & Ashok Kumar, “Materials Characterization Techniques”, CRC Press,2009.
4. Thomas G., “Transmission Electron Microscopy of Metals”, John Wiley, 1996.
5. Weinberg, F., “Tools and Techniques in Physical Metallurgy”, Volume I & II, Marcel and Decker, 1970.
6. Yang Leng, “Materials Characterization: Introduction to Microscopic and Spectroscopic Methods”, 2nd Edition., Wiley, 2013.
7. Angelo, P.C., “Materials Characterisation”, Cengage Publication, 1st Edition, 2016.

CO	PO					
	1	2	3	4	5	6
1	3	2			2	2
2	3	2			2	2
3	3	2			2	2
4	3	2			2	2
5	3	2			2	2
Avg.	3	2			2	2

MS3004 SUSTAINABLE AND GREEN MANUFACTURING

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

The course aims to impart knowledge on sustainable aspects of manufacturing and green solutions for the manufacturing industry.

UNIT I INTRODUCTION TO SUSTAINABLE GREEN MANUFACTURING 9

Sustainable development, Need for Green Manufacturing, Motivations and Barriers to Green Manufacturing, Environmental Impact of Manufacturing, Strategies for sustainable and green Manufacturing.

UNIT II METRICS FOR GREEN MANUFACTURING 9

Metrics for Ecology, Financial Metrics, Metrics for Society, Multiple metrics, Life cycle Assessment (LCA), Types of LCA, Impact Assessment, Risk Assessment, Material flow analysis, Energy flow analysis, Metrics development methodologies, Metrics development for component selection.

UNIT III ENVIRONMENTALLY BENIGN MANUFACTURING 9

Green Supply Chain (GSC), Challenges and Future of GSC, Packaging, Transportation impact assessment of transportation, Pellet Utilization, Application Potential of Clean Energy Supply in Green Manufacturing, Technological Performance and cost of Clean Energy Supply.

UNIT IV GREEN MACHINING 9

Cutting tool sustainability, cutting fluids and problems related to cutting fluids, Dry cutting, Minimum Quantity Lubrication (MQL) and its performance in machining, Classification and design of MQL Systems, Challenges of Implementing MQL and Dry Cutting, Green metal working fluids, Cryogenics, Nano fluids.

UNIT V SUSTAINABILITY IN MODERN MANUFACTURING INDUSTRIES 9

New product development and mass customization, Reconfigurable Manufacturing Enterprise, Sustainability assessment of innovative product design, Lean Production, Agile manufacturing, Remanufacturing and Recycling.

TOTAL: 45 HOURS

COURSE OUTCOMES:

At the end of the course, the students would be able to

CO1: Explain the role of sustainability in manufacturing.
CO2: Identify the green manufacturing metrics and Evaluate the life cycle assessment of products.
CO3: Describe the use of green supply chain and clean energy in green manufacturing.
CO4: Apply the various environmentally friendly cooling-lubrication techniques in machining.
CO5: Differentiate the sustainability aspects of the modern manufacturing industries.

REFERENCES:

1. Dornfeld David A., “Green manufacturing: fundamentals and applications”, 2012, Springer Science & Business Media.
2. Davim J.P., “Sustainable manufacturing”, 2013, John Wiley & Sons.
3. Garbie, Ibrahim. “Sustainability in manufacturing enterprises: Concepts, analyses and assessments for industry 4.0”, 2016, Springer.
4. Madu Christian N., “Handbook of environmentally conscious manufacturing”, 2022, Springer Nature.
5. Dixit Uday S., D. K. Sarma, and J. Paulo Davim. “Environmentally friendly machining”, 2012, Springer Science & Business Media.

CO	PO					
	1	2	3	4	5	6
1	2		3	1	1	3
2	3	1	3	1	3	3
3	3		3	3	3	3
4	3		3	3	3	3
5	3	1	3	3	3	3
Avg	2.8	1	3	2.2	2.6	3

Attested

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PD3151 INTEGRATED PRODUCT DESIGN AND DEVELOPMENT

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

To understand and apply the principles and concepts in Integrated Product Design and Development.

UNIT I INTRODUCTION TO PRODUCT DEVELOPMENT 9

Introduction – Characteristics of Successful Product Development – Product Development Team – Challenges of Product Development – Duration and Cost of Product Development – Product Development Process – Concept Development: The Front-End Process – Adapting the Generic Product Development Process – Product Development Process Flows – Product Development Organizations – Tournament Structure of Opportunity Identification – Opportunity Identification Process.

UNIT II PRODUCT PLANNING, CUSTOMER NEEDS IDENTIFICATION AND PRODUCT SPECIFICATION 9

Product Planning Process – Identifying Customer Needs – Importance of Latent Needs – Process of Identifying Customer Needs – Definition of Specifications – Time to Establish Specification – Establishing Target Specifications – Setting the Final Specifications.

UNIT III PRODUCT CONCEPT GENERATION, SELECTION AND TESTING 9

Activity of Concept Generation – Concept Selection – Concept Screening – Concept Scoring – Caveats – Concept Testing.

UNIT IV PRODUCT ARCHITECTURE, INDUSTRIAL DESIGN, DESIGN FOR MANUFACTURING 9

Product Architecture – Definition – Implications – Establishing the Architecture – Delayed Differentiation – Platform Planning – Related System-Level Design Issues – Industrial Design – Assessing the Need for Industrial Design – Impact of Industrial Design – Industrial Design Process – Management of the Industrial Design Process – Assessing the Quality of Industrial Design – Design for Manufacturing – DFM Process.

UNIT V PROTOTYPING, PRODUCT DEVELOPMENT ECONOMICS AND MANAGEMENT 9

Prototyping – Principles, Technologies & Planning – Product Development Economics – Elements of Economic Analysis – Economic Analysis Process – Managing Projects – Understanding and Representing Tasks – Baseline Project Planning - Accelerating Projects – Project Execution – Postmortem Project Evaluation.

TOTAL: 45 PERIODS

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

CO1 Apply the principles of concept development process and opportunity identification process.

CO2 Apply the principle of product planning; customer needs analysis and set product specifications for new product design and development.

CO3 Generate, select, screen, test concepts for new product design and development.

CO4 Apply the principles of product architecture, industrial design and design for manufacturing in new product development.

CO5 Apply the principles of prototyping techniques. Apply the concepts of economics principles; project management practices in accelerating the new product development activity.

REFERENCES:

1. Karl T.Ulrich, Steven D.Eppinger, Anita Goyal, "Product Design and Development",McGraw –Hill Education (India) Pvt. Ltd, 4th Edition, 2012.
2. Kenneth Crow, "Concurrent Engineering/Integrated Product Development". DRM Associates, 6/3,Via Olivera, Palos Verdes, CA 90274, (310) 377-569,Workshop Book
3. Kevin N Otto, Kristin L Wood, “Product Design — Techniques in Reverse Engineeringand New Product Development”, Pearson Education, Inc, 2016
4. Stephen Rosenthal, "Effective Product Design and Development", Business One Orwin,Homewood, 1992
5. Stuart Pugh, "Total Design – Integrated Methods for successful Product Engineering", Addison Wesley Publishing, Neyourk, NY,1991.

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	3	3	3	3	2	3
2	3	3	3	3	2	3
3	3	3	3	3	2	3
4	3	3	3	3	2	3
5	3	3	3	3	2	3
Avg.	3	3	3	3	2	3

MS3005 FINANCIAL MANAGEMENT AND ACCOUNTING L T P C
3 0 0 3

COURSE OBJECTIVES:

Preparing the Profit and loss account balance sheet and budget, various cost accounting methods, evaluating and marking investment decisions, select the most desirable projects and developing financial decisions.

UNIT I FINANCIAL ACCOUNTING 9

Introduction to Accounting-Trading Account, Profit and Loss Account, Balance sheet statement, Cash flow and fund flow analysis, Working capital management– Depreciation.

UNIT II COST ACCOUNTING 9

Cost Accounting systems: Job costing, Process costing, Allocation of Overheads, Activity-based Costing, Differential and Incremental cost.

UNIT III BUDGETING 9

Requirements for a sound budget, Fixed budget – Preparation of sales and Production budget, Flexible budgets and budgetary control.

UNIT IV FINANCIAL MANAGEMENT 9

Investment decisions – Capital investment process, Type of investment proposals, Investment appraisal techniques – Payback period method, Accounting rate of return, Net present value method, Internal rate of return

UNIT V FINANCIAL DECISIONS 9

Cost of capital – Capital structure – Dividend policy – Leasing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able

CO1: To Profit and loss account balance sheet and other accounting.
CO2: To apply the various cost accounting methods.
CO3: To prepare a budget.
CO4: To Evaluate, make investment decisions and select the most desirable projects.
CO5: To make financial decisions.

REFERENCES:

1. Bhattacharya, S.K. and John Deardon, "Accounting for management – Text and Cases", 3rd edition, Vikas Publishing house, New Delhi, 2015.
2. Charles Horngren, Gary Sundem, William Stratton, Dave Burgstahler, Jeff Schatzberg "Introduction to Management Accounting", 16th edition, Pearson, 2013.
3. James, Van Horne, John Wachowicz, "Fundamental of Financial Management", Pearson Education, 13th Edition, 2008.
4. Pandey, I.M., "Financial Management", Vikas Publishing House, New Delhi, 11th Edition, 2016

CO	PO					
	1	2	3	4	5	6
1	3	3	1	1	3	1
2	3	2	1	1	3	1
3	3	2	2	1	3	2
4	3	3	3	1	3	2
5	3	2	2	1	3	2
Avg.	3	2.4	1.8	1	3	1.6

ED3052	MATERIAL HANDLING SYSTEMS AND DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES: To impart students on the need, use, application and design of different material handling techniques, equipment and machines used in common use and in industrial sector.

UNIT I INTRODUCTIONS AND DESIGN OF HOISTS 9

Types, selection and applications, Design of hoisting elements: Welded and roller chains-Hemp and wire ropes - Design of ropes, pulleys, pulley systems, sprockets and drums, Load handling attachments. Design of forged hooks and eye hooks – crane grabs - lifting magnets -Grabbing attachments-Design of arresting gear.

UNIT II DRIVES OF HOISTING GEAR 9

Hand and power drives - Traveling gear - Rail traveling mechanism - cantilever and mono rail cranes-slewing ,jib and luffing gear-cog wheel drive-selecting the motor ratings.

UNIT III CONVEYORS 9

Types-description-design and applications of Belt conveyors, apron conveyors and escalators Pneumatic conveyors, Screw conveyors and vibratory conveyors.

UNIT IV ELEVATORS 9

Bucket elevators: design - loading and bucket arrangements - Cage elevators - shaft way, guides, counter weights, hoisting machine, safety devices.

UNIT V INTEGRATED DESIGN 9

Integrated Design of systems - Valve Gear Mechanisms, Portable Air Compressor, Hay-Balelifter, Cam Testing Machine and Gear Box Design more than six speed.

TOTAL: 45 PERIODS

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

CO1 design hoists used in any material handling applications.
CO2 design drive mechanisms and hoisting gear for different material handling applications.
CO3 design different conveyor systems for material handling applications.
CO4 design bucket, cage and forklift elevators for to and fro transportation of materials in vertical direction.
CO5 design of integrated mechanical system for machine tools, power transmission and engine parts

REFERENCES:

1. Alexandrov, M.,MaterialsHandlingEquipments,MIRPublishers,1981.
2. Boltzharol, A., Materials Handling Handbook,TheRonaldPressCompany,1958.
3. Norton. L Robert. “Machine Design–An Integrated Approach” Pearson Education, 2nd Edition, 2005.
4. Rudenko,N.,Materialshandlingequipment,ELnveePublishers,1970.
5. Spivakovsy,A.O.and Dyachkov,V.K., Conveying Machines, Volumes I and II,MIR Publishers,1985.

APPROVED DATA BOOKS:

1. P.S.G. Tech., “Design Data Book”, Kalaikathir Achchagam, Coimbatore, 2003.
2. Lingaiah. K. and Narayana Iyengar, “Machine Design Data Hand Book”, Vol. 1 & 2, Suma Publishers, Bangalore, 1983

CO	PO					
	1	2	3	4	5	6
1	2		3	2	2	3
2	2		3	2	2	3
3	2		3	2	2	3
4	2		3	2	2	3
5	2		3	2	2	3
Avg.	2		3	2	2	3

Attested

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MS3006	MATERIALS MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The objective of this course is to impart knowledge on aggregate planning, inventory management, purchasing techniques, warehouse management and Just in time production**.**

UNIT I INTRODUCTION 9

Operating environment- supply chain concept, Materials Management, Supply chain matrices, aggregate planning, manufacturing planning and control system - manufacturing resource planning - enterprise resource planning - making the production plan

UNIT II MATERIALS PLANNING 9

Materials requirements planning: - Dependent demand, Independent Demand, Product Structure, Bill of materials - Distribution Requirement planning - capacity requirement planning - scheduling orders - production activity control - codification.

UNIT III INVENTORY MANAGEMENT 9

Function of inventories, Types of inventories, Inventory cost - Single period model:- News Vendor problem - Multi period model:– Deterministic and Probabilistic Fixed Order Quantity & Fixed Time Period model, Lead time, Reorder Point, Safety Stock - Selective inventory control approaches:- ABC, VED, FSN.

UNIT IV PURCHASE MANAGEMENT 9

Establishing specifications-selecting suppliers-price determination-forward buying-mixed buying strategy-price forecasting-buying seasonal commodities-purchasing under uncertainty-demand -price forecasting-purchasing under uncertainty-purchasing of capital equipment, international purchasing

UNIT V WAREHOUSE MANAGEMENT 9

Principles of warehousing Storage and handling systems (palletized and non-palletized), Warehousing functions – types –Stores management-stores systems and procedures-incoming materials control-stores accounting and stock verification-Obsolete, surplus, and scrap-value analysis-material handling-transportation and traffic management – Just in time production, Lean production

TOTAL: 45 HOURS

COURSE OUTCOMES:

Upon completion of the course the student will be able to:

CO1: Explain aggregate, enterprise resource and manufacturing planning
CO2: Summarize the various aspects of materials planning
CO3: Analyze the inventory management
CO4: Explain Purchase Management
CO5: Discuss the warehouse management

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COs	POs					
	1	2	3	4	5	6
1	3		2	1		3
2	3		2	1		3
3	3		2	1		3
4	3		2	1		3
5	3		2	1		3
Avg.	3		2	1		3