THE VISION OF THE DEPARTMENT OF MANUFACTURING ENGINEERING:
To be an outstanding department where students can gain acumen to be brewed them such that they unswervingly meet the needs of the society.

THE MISSION OF THE DEPARTMENT OF MANUFACTURING ENGINEERING:
❖ To foster the growth of its members and develop them in new vistas promoting them to their fullest cognition.
❖ To be nationally recognized as the leader of Manufacturing Engineering in education and research.
❖ Bring augmentation to the Department, College and University.
❖ Discern the potential of its members.
❖ Have its members vivaciously conscripted nationally by employees and graduate programs.
❖ To evoke new ideas in the minds of its members and infuse nascent technology to modern era of manufacturing.
PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I. To train students to independently carry out research / investigations, prepare technical report/ documents and development work to solve practical problems.

II. To train students to demonstrate mastery in the area of computer integrated manufacturing at a higher level.

III. To train students to pursue professional career in manufacturing industries/educational institutions/research & development organisations as well as in allied fields and excel as an individual and also as a team player in multidisciplinary environments.

IV. To train students to provide solutions to industrial/research problems considering economic, environmental and social contexts for sustainable development.

PROGRAMME OUTCOMES (POs):

The programme outcomes of the Computer Integrated Manufacturing Postgraduate students are given below:

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document

PO3: 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 a level higher than the requirements in the appropriate bachelor programme.

PO4: Ability to apply inter-disciplinary knowledge in various functional areas of Computer Integrated Manufacturing and will be familiar with engineering hardware/software and equipments as practiced in manufacturing industries to formulate and solve real time problems.

PO5: Identify and apply automation and use the latest technology in continuous improvement of manufacturing systems and processes with the integration of design system.

PO6: Motivated to have out-of-the-box thinking in becoming entrepreneurs/start-ups by developing new manufacturing systems and assessing the feasibility of technical, financial, research initiatives, and social perspectives.
PEO / PO Mapping:

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TOTAL CREDITS TO BE EARNED FOR THE AWARD OF DEGREE = 71
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EMPLOYABILITY ENHANCEMENT COURSES (EEC)

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**SUMMARY**

**M.E. COMPUTER INTEGRATED MANUFACTURING**

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OBJECTIVES:
- To enable them to estimate the value of the parameters involved in the specific distribution from a possible continuum of alternatives.
- To give an idea of testing the statistical hypothesis claimed based on a set of data points using suitable test statistics which follows standard sampling distributions.
- To establish a relationship that make it possible to predict one or more variable in terms of others using correlation and regression analysis.
- To introduce the various experimental designs and their corresponding analysis of variance which play vital role in many real time scenarios.
- To impart knowledge of handling random vectors which represent random variables in multi-dimensional space.

UNIT I ESTIMATION THEORY
12

UNIT II TESTING OF HYPOTHESIS
12
Tests based on Normal, t, $\chi^2$ and $F$ distributions for testing of means, variance and proportions – Analysis of $r \times c$ tables – Goodness of fit.

UNIT III CORRELATION AND REGRESSION
12
Multiple and Partial Correlation - Method of Least Squares- Plane of Regression - Properties of Residuals - Coefficient of Multiple Correlation - Coefficient of Partial Correlation - Multiple Correlation with total and partial correlations - Regression and Partial correlations in terms of lower order coefficients.

UNIT IV DESIGN OF EXPERIMENTS
12
Analysis of variance – One-way and two-way classifications – Completely randomized design – Randomized block design – Latin square design.

UNIT V MULTIVARIATE ANALYSIS
12

TOTAL: 60 PERIODS

OUTCOMES:
At the end of the course, students will be able to
CO1 Obtain the value of the point estimators using the method of moments and method of maximum Likelihood.
CO2 Use various test statistics in hypothesis testing for mean and variances of large and small samples.
CO3 Determine the regression line using the method of least square and also to calculate the partial and multiple correlation coefficient for the given set of data points.
CO4 Test the hypothesis for several means using one way, two way or three way classifications.
CO5 Get exposure to the principal component analysis of random vectors and matrices.
REFERENCES:

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OBJECTIVES:
- To understand fundamental concepts of computer graphics and its tools in a generic framework, geometric models using curves, surfaces and solids.
- To provide clear understanding of CAD systems for 3D modeling and viewing.
- To create strong skills of assembly modeling and prepare the student to be an effective user of a standards in CAD system.

UNIT I INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS
Graphic display, Line and circle drawing algorithms - Filled area primitives, attributes to output primitives - Two Dimensional Geometric transformations, Viewing and clipping – Coordinate Transformations – Three dimensional transformations.

UNIT II CURVES AND SURFACES MODELLING

UNIT III NURBS AND SOLID MODELING

UNIT IV VISUAL REALISM

UNIT V ASSEMBLY OF PARTS AND PRODUCT LIFE CYCLE MANAGEMENT
Mass properties, assembly modeling, Product Data Exchange – Geometric tolerances, Tolerance practice in drafting and manufacturing – Tolerance modeling, analysis and synthesis – Managing product life cycle

LECTURE : 45 PERIODS

LIST OF EXPERIMENTS:

CAD MODULE
1. Sketching and Part modelling (Solid modelling, Surface modelling, Feature manipulation) of mechanical components using CAD software package.
2. Assembly (Constraints, Exploded Views, Interference check) and Drafting (Layouts, Geometric Dimensions &Tolerance Standards, Sectional Views, & Detailing) of mechanical components using CAD software package.
3. Working with CAD Data Exchange formats: IGES, PDES, PARASOLID, DXF and STL.
4. Study and exercise on freeform modelling.
5. Reverse engineering the given product/component and convert the data into 3D model.

Attested,

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025
CAE MODULE
7. Finite Element Analysis (FEA) using Pre-processing (solid modelling, meshing, analysis setup) and post processing (graphical display and report) with CAE software package
8. Finite Element Analysis (FEA) for plastic deformation using nonlinear material models with CAE software package

LAB : 60 PERIODS

LIST OF ITEMS (Hardware/Software) REQUIRED:
2. CAD software Package
3. Open source CAD software for Additive Manufacturing
4. CAE Software package

TOTAL: 105 PERIODS

COURSE OUTCOMES:
At the end of the course, students will be able to
CO 1: Solve 2D and 3D transformations of geometric models.
CO 2: Formulate the curve and surface model to CAD system.
CO 3: Formulate the NURBS and solid model to CAD system.
CO 4: Create visual realism of the geometric models.
CO 5: Perform assembly modeling and tolerance practices

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REFERENCES:
OBJECTIVES:
- To introduce the evolution of CAD, CAM, CIM, engineering product specification and interpreting geometric specifications.
- To train the candidates on the integration of Computer Aided Design and Computer Aided Manufacturing and to introduce with the implementation of CAD and CAM in manufacturing process
- To impart knowledge on manual part program and generation of CNC part program using Computer Aided Manufacturing packages and to introduce the importance of Internet of Things in Computer Aided Manufacturing.

UNIT I INTRODUCTION TO CAM
Introduction CAD, CAM, CAE, CIM, system configuration for CAM including hardware and software, evolution of product realization, historical development, engineering product specification. Geometric Tolerancing – ASME, ISO and DIN standards, interpreting geometric specifications, multiple part features and datum.

UNIT II CAD AND CAM INTEGRATION

UNIT III CNC MACHINES
CNC Machine building, structural details, guide ways –Friction, Anti friction and other types of guide ways, elements used to convert the rotary motion to a linear motion – Screw and nut, recirculating ball screw, spindle assembly, torque transmission elements – gears, timing belts, flexible couplings, Bearings, Spindle drives and feed drives, Linear Motors- open loop and closed loop control, Axis measuring system, grating, linear scale, encoder, laser interferrometer - Axes & Spindle Cooling System - Through Coolant & Shower Coolant - Integral Spindle With HSK & Big Plus Spindle - Double Ball Screws - Grease Lubricating System - Probing For Zero Offsets and First Off Inspection - Tool Breakage Detecting System - In Process Gauging System, ATC, APC.

UNIT IV PROGRAMMING OF CNC MACHINES
Structure of CNC program, Coordinate system, G & M codes, cutter radius compensation, tool nose radius compensation, tool wear compensation, canned cycles, mirroring features, Manual part programming for CNC turning, machining center, macro programming, wire electric discharge machining, abrasive water jet cutting machine, bulk and sheet metal forming, generation of CNC program using CAM softwares.

UNIT V IOT IN CAM
Introduction, overview of IOT enabled manufacturing system, Real-time and multi-source manufacturing information sensing system, IOT enabled smart assembly station, cloud computing based manufacturing resources configuration method, Real-time key production performances analysis method, Real-time information driven production scheduling system.

TOTAL: 45 PERIODS
COURSE OUTCOMES:
At the end of the course, students will be able to
CO 1: Recognize the importance of CAD, CAM, CIM, Engineering product specification and interpreting geometric specifications.
CO 2: Improve knowledge on the integration of CAD and CAM.
CO 3: Exhibit competency in manual part program and generation of CNC part program using CAM packages.
CO 4: Describe the implementation of CAD and CAM in manufacturing processes
CO 5: Explain applications of IOT in computer aided manufacturing

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REFERENCES:
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
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)

UNIT III VAT POLYMERIZATION, MATERIAL EXTRUSION & SHEET LAMINATION TECHNOLOGIES

UNIT IV POWDER BED FUSION, BINDER JETTING, MATERIAL JETTING & DIRECT ENERGY DEPOSITION TECHNOLOGIES
UNIT V MATERIALS AND APPLICATIONS OF SFM


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.

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REFERENCES:
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:
OBJECTIVES:
● To familiarize students with manual CNC part programming and part programs using CAM packages for milling and turning machines.
● To train students with dimensional and geometric measurements for machined features using video measuring system and coordinate measuring machine.
● To get hands on knowledge on programming logic controller - ladder programming, robot programming and Material requirements planning.

LIST OF EXPERIMENTS:
1. Programming and simulation for various operations using canned cycle for CNC turning Centre.
2. Programming and simulation for machining of internal surfaces in CNC turning Centre
3. Programming and simulation for profile milling operations
4. Programming and simulation for circular and rectangular pocket milling
5. Programming and simulation using canned cycle for CNC Milling such as peck drilling and tapping cycle
6. CNC code generation using CAM software packages – Milling
7. CNC code generation using CAM software packages – Turning
8. Dimensional and geometric measurement of machined features using VMS and CMM
9. PLC ladder logic programming.
10. Robot programming for Material handling applications.
11. Study on RDBMS and its application in problems like inventory control MRP.
12. Design and fabrication of a component using extrusion based additive manufacturing.

TOTAL: 60 PERIODS

LIST OF ITEMS (Hardware/Software) REQUIRED:
1. Computers 30
2. CAM Software for 3 axis machining or more
3. CNC Production type turning or Machining center
4. Video Measuring System
5. Coordinate Measuring Machine
6. Surface Roughness tester
7. 5-axis Robot
8. Programmable Logic Controller with ladder logic programming software
9. RDBMS Package with relevant modules like Inventory Control and MRP
10. 3D Printer
COURSE OUTCOMES:
At the end of the course, students will be able to
CO 1: Exhibit competency in manual CNC part programming for milling and turning machines
CO 2: Demonstrate generation of part programs using CAM packages for milling and turning Machines and geometric measurements of machined features using CMM
CO 3: Demonstrate PLC ladder and robot programming and appreciate the application RDBMS in MRP

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OBJECTIVES:
● To teach the students about the concepts of metrology.
● To train the students in the field of surface roughness measurement, form measurements and interferometry.
● To introduce some fundamental principles of CAI, Laser metrology, Image processing on Machine vision.

UNIT I CONCEPTS OF METROLOGY

UNIT II MEASUREMENT OF SURFACE ROUGHNESS

UNIT III INTERFEROMETRY AND FORM MEASUREMENTS

UNIT IV COMPUTER AIDED INSPECTION AND LASER METROLOGY

UNIT V MACHINE VISION AND IMAGE PROCESSING

LECTURE : 45 PERIODS

LIST OF EXPERIMENTS:
1. Calibration of comparators using slip gauges
2. Assessment of gauge surfaces using optical flats
3. Measurement of Surface roughness of specimens using contact method
4. Non-contact surface roughness measurement of specimens
5. Counting of fringes produced by Michelson’s interferometer
6. Measurement of dimensional features using machine vision system
7. Study exercises on clean room behaviour
8. Roundness and cylindricity measurement of components
9. Study on flatness measurement of surface using autocollimator
10. Measurement of dimensional features of a specimen - Contact type using CMM.

LAB: 60 PERIODS

TOTAL: 105 PERIODS

COURSE OUTCOMES:
At the end of the course, students will be able to
CO 1: Explain the fundamental concepts of measurement, standards, calibration, maintenance of laboratory facilities and handling of metrological equipments
CO 2: Explain roughness and its applications in manufacturing research, learn the important concepts, principles and applications related to interferometry.
CO 3: Discuss the use of interferometry related sophisticated measurement and inspection facilities.
CO 4: Execute the concepts of Computer aided inspection technologies for industrial Situations, design and develop new inspection techniques.
CO 5: Describe the importance of image processing techniques and the possibilities of developing new heuristics for image processing related to metrology.

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REFERENCES:
OBJECTIVES:

- To introduce students with Current Trends in Manufacturing Planning and Control System
- To be familiarized with the functions of automated shop floor control and Computerized Process Monitoring.

UNIT I MANUFACTURING PLANNING AND CONTROL AND FORECASTING

UNIT II AGGREGATE PRODUCTION PLANNING

UNIT III RESOURCE PLANNING

UNIT IV SHOP FLOOR CONTROL
Shop Floor Control - Functions - Shop Floor Control System - Order Release - Order Scheduling - Order Progress - Operation Scheduling-Priority Rules for Job Sequencing - The Factory Data Collection System - Online and Offline Data Collection Systems - Case studies.

UNIT V PROCESS MONITORING AND CONTROL

TOTAL: 45 PERIODS
COURSE OUTCOMES:
At the end of the course, students will be able to
CO 1: Gain Knowledge on activities of Manufacturing Planning and Control System and to select suitable Forecasting technique
CO 2: Managing supply and demand.
CO 3: Perceive Inventory management and Resource Requirements.
CO 4: Evaluate the functions of Shop Floor Control and associated systems.

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REFERENCES:
CI3203 ADVANCES IN MANUFACTURING TECHNOLOGY

OBJECTIVES:
- To analyze and compare different unconventional machining processes, precision machining processes and modern metal forming processes.
- To formulate smart manufacturing systems
- To implement the concepts of AI and ML in Manufacturing

UNIT I UNCONVENTIONAL MACHINING
Introduction – Electrical discharge machining – Micro electrical discharge machining - Wire electrical discharge machining – Micro wire electrical discharge machining - Electro chemical machining – Micro electro chemical machining – Abrasive water jet machining – Micro abrasive water jet machining – Laser assisted machining – Cryogenic machining – Hybrid machining processes

UNIT II PRECISION MACHINING

UNIT III MODERN METAL FORMING

UNIT IV INDUSTRY 5.0

UNIT V DATA ANALYTICS, MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE
Data Analytics – Introduction to Machine Learning and deep learning, Supervised and unsupervised algorithms – Applications of machine learning algorithms – Introduction to artificial intelligence and Artificial Neural Network in manufacturing – Case studies using chatGPT.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, students will be able to
CO 1: Differentiate unconventional machining processes
CO 2: Apply different precision machining techniques.
CO 3: Apply modern metal forming processes.
CO 4: Demonstrate the Industry 5.0 concepts.
CO 5: Apply artificial intelligence and machine learning concepts

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REFERENCES:

OBJECTIVES:
- To familiarize the students with manual part program and generation of program using CAM package.
- To gain knowledge in robot programming, traditional and nontraditional micro machining processes, and fabrication of composite materials.
- To familiarize the students with additive manufacturing processes.

LIST OF EXPERIMENTS:
1. Generation of CNC part programs and machining components for 5 axis CNC machining center.
2. Machining using CNC wire EDM.
3. Thin film multilayer coating using PVD coating equipment.
4. Machining using Abrasive water jet machine.
5. Micro machining – micro turning, micro drilling & micro milling
6. Nontraditional micro machining – Electro Chemical Micro Machining (EMM)
7. Manufacturing of Polymer based composites using Resin Transfer Moulding Machine (RTM)
8. Fabrication of metal matrix composite using stir casting setup
9. Topology optimisation and fabrication of components using additive manufacturing process
10. Fabrication of components using different tool path strategies with material extrusion additive manufacturing process.
11. Optimisation of build time and support structure for vat photo polymerisation additive manufacturing process.
12. 5 Axis CNC Machining of aerospace alloys.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
At the end of the course, students will be able to
CO1: Demonstrate manual part program and to generate CNC program using CAM packages
CO2: Compare traditional and nontraditional micro machining processes and perform composite material fabrication.
CO3: Build parts using different additive manufacturing process.

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OBJECTIVES:
- To familiarize students with real life situations in industrial organizations.
- To accelerate the learning process.
- To train the students to apply their gained knowledge in an Industrial organization.
- To expose students with best working practices and with ethical values.
- To inculcate integrity, responsibility, and self-confidence in student's mind.

DURATION: The students have to undergo practical Inplant Training / Internship for four weeks (During Second Semester holidays) in recognized industrial establishments/educational institutions / research and development organizations under the guidance of a faculty member. Periodically they have to communicate to the guide about the progress in the industry. At the end of the training, they have to submit a project report with following information:

1. Profile of the Industry
2. Product range
3. Organization structure
4. Plant layout
5. Processes/Machines/Equipment/devices
6. Personnel welfare schemes
7. Details of the training undergone
8. Learning points.

The presentation of the above will be carried out during third semester.

COURSE OUTCOMES:
At the end of the course, students will be able to
CO 1: Describe structure of the Industrial organization.
CO 2: Realize the various functions of management.
CO 3: Understanding of groups and group dynamics.
CO 4: Describe the industrial culture.
CO 5: Develop skills to read, write and comprehend.

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Centre for Academic Courses
Anna University, Chennai-600 025
OBJECTIVES:
- To identify industrial problem and solve them.
- To develop good written and oral communication skills and leadership skills.
- To train the students in preparing the project reports and to face reviews.
- To develop the ability to solve a specific Industrial problem.
- To accelerate the learning process.

EVALUATION:
- Project work evaluation is based on Regulations of Credit System University Departments - Postgraduate programmes of Anna University

COURSE OUTCOMES:
At the end of the course, students will be able to
CO 1: Apply the knowledge gained from theoretical and practical courses in solving problems.
CO 2: Recognize the importance of literature review.
CO 3: Realize the importance of solving problems using literature review.
CO 4: Recognize the modern concepts in technology and design.
CO 5: Develop skills to read, write and comprehend.

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OBJECTIVES:
- To produce factual results of their applied research idea in the Manufacturing Engineering.
- To improve research and development activities.
- To develop technical competency to provide solutions for problems.
- To accelerate the learning process.
- To develop good communication skills.

EVALUATION:
- Project work evaluation is based on Regulations of Credit System University Departments - Postgraduate programmes of Anna University

COURSE OUTCOMES:
At the end of the course, students will be able to
- CO 1: Apply the knowledge gained from theoretical and practical courses in solving problems.
- CO 2: Demonstrate a strong working knowledge of ethics and professional responsibility.
- CO 3: Demonstrate effective organizational leadership and change skills.
- CO 4: Realize the importance of solving problems using literature review.
- CO 5: Develop skills to read, write and comprehend.

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OBJECTIVES:

- To impart knowledge on welding Metallurgy, Design and Special welding processes.
- To elaborate gating system design and casting metallurgy and to provide knowledge on Special casting processes.
- To familiarize the students with automation and environmental aspects and standards.

UNIT I  WELDING DESIGN  9

UNIT II  SPECIAL WELDING PROCESSES  9

UNIT III  CASTING DESIGN AND SOLIDIFICATION  9
Introduction - - Pattern allowances - Introduction of gating design - Types of gate - Pouring time calculation - Aspiration effects in gating system - Problem solving on gating design - Solidification analysis - Risering methods - Shape factor - Feeding & Chills effect - Problem related to riser design - Design of thin and unequal sections - mechanism of solidification - Rapid solidification processing (RSP) - Melt spinning - Roll quenching - Vibratory solidification - Splat cooling - Thixoforming - Rheocasting - Single crystal growing - Casting defects, inspection, diagnosis and rectification - Case studies

UNIT IV  SPECIAL CASTING PROCESSES  9
Evaporative Pattern Casting Process and full mould process - Vacuum sealed moulding - vacuum casting - Magnetic Moulding - Squeeze Casting - Mega Casting - Plaster mould casting - Ceramic mould casting.

UNIT V  AUTOMATION ENVIRONMENTAL SPECIFICATION AND STANDARDS  9

TOTAL: 45 PERIODS
COURSE OUTCOMES:
At the end of the course, students will be able to
CO 1: Use design knowledge to overcome defects in welding
CO 2: Select suitable welding process for the given applications.
CO 3: Use design knowledge to produce quality casting.
CO 4: Select suitable casting process for the given applications.
CO 5: Implement automation principles with environment consciousness techniques in welding and casting plants and learn to follow standards.

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REFERENCES:
OBJECTIVES:

- To learn tool nomenclature, mechanics of metal cutting and forces in metal cutting
- To know the thermal aspects in machining, tool materials, tool life and wear mechanisms

UNIT I TOOL NOMENCLATURE

Single point tool - significance of the various angles provided and nose radius- American, German CIRP and orthogonal system of tool nomenclature, System of tool nomenclature and its conversion, nomenclature of drills, milling cutters and broaches - grinding wheels, Need for chip breakers.

UNIT II MECHANICS OF METAL CUTTING

Mechanisms of formation of chips-types of chips and the conditions conducive for the formation of each type, built-up edge and its effects, Orthogonal Vs Oblique cutting - Merchant’s circle diagram- Force and velocity relationship, shear plane angle, Energy considerations in machining - Ernst Merchant’s theory of shear angle relationship-original assumptions and modifications made, Chip formation mechanism in micro and nanomachining.

UNIT III FORCES IN MACHINING

Forces in turning, drilling, milling and grinding, conventional Vs climb milling-mean and maximum cross sectional areas of chip in milling-specific cutting pressure-specific horse power-requirements of tool dynamometers-construction and principle of operation of tool dynamometers for turning, drilling and milling, Analysis of cutting forces and process optimization – a case study. Monitoring and controlling of process parameters – A case study using AI and ML.

UNIT IV THERMAL ASPECTS IN MACHINING

Sources of heat generation in machining-temperature measurement techniques in machining, Temperature distribution, Zones, measurement -Latest trends in cutting tool temperature measurement. Functions of cutting fluid-characteristics of cutting fluid-types, modes of applications, additives-application of cutting fluids- dry machining, Minimum Quantity Lubrication (MQL) machining.

UNIT V TOOL MATERIALS, TOOL WEAR AND TOOL LIFE


TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1: Understanding various tool geometries of single point and multi-point cutting tools based on different tool reference systems and apply for tool and cutter grinding.

CO 2: Analytically predict the force, velocity relationship and study their effects on chip formation mechanism during orthogonal and oblique cutting.

CO 3: Evaluation of cutting forces generated during various machining operations by selecting suitable cutting force and power sensors.

CO 4: Determine the tool temperature by selecting suitable temperature sensors and demonstrate means of reducing heat generation by appropriate cooling strategies.
CO 5: Select suitable cutting tool materials to efficiently apply for different tool/work combinations to optimize machining performance.

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OBJECTIVES:
- Gain knowledge of innovation in Product design & development and brief overview of development of new products through conceptualization, design, and testing phases.
- Connect diverse aspects of product development to manufacturing and industrial design. Interpret the fundamental concept of Rapid Prototyping.
- Develop products that are suitable for the demands of society.

UNIT I PRODUCT DEVELOPMENT AND CONCEPT SELECTION

UNIT II PRODUCT ARCHITECTURE
Product architecture – Implication of the architecture – Establishing the architecture – Related system level design issues- Modular product- Case studies

UNIT III INDUSTRIAL AND MANUFACTURING DESIGN
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 - Case studies

UNIT IV PROTOTYPING AND ECONOMIC ANALYSIS

UNIT V MANAGING PRODUCT DEVELOPMENT PROJECTS
Sequential, parallel and coupled tasks - Baseline project planning – Project Budget- Project execution – Project evaluation- patents- patent search-patent laws-International code for patents.

COURSE OUTCOMES:
At the end of the course, students will be able to
CO 1: Understand the basic concept of product development
CO 2: Design and develop new products in a systematic using the studied tools and techniques.
CO 3: To associate various aspects of product development with industrial design and manufacturing.
CO 4: To understand the fundamental concept of Rapid Prototyping.
CO 5: To be able to design products which are suitable for the needs of the society.
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REFERENCES:
OBJECTIVES:

- To impart the knowledge in electronic packaging technology

UNIT I  INTRODUCTION TO ELECTRONICS MANUFACTURING  9
History, definition, wafer preparation by growing, machining, and polishing, diffusion, microlithography, etching and cleaning, Printed Circuit Boards, types- single sided, double sided, multi-layer and flexible printed circuit board, design, materials, manufacturing, inspection. Electronic packaging – Through Hole Technology (THT) and Surface Mount Technology (SMT).

UNIT II  COMPONENTS AND PACKAGING  9
Through-hole components – axial, radial, multi leaded, odd form. Surface mount components - active, passive. Interconnections - chip to lead interconnection, die bonding, wire bonding, TAB, Flip chip, chip on board, multi-chip module, direct chip array module, leaded, leadless, area array and embedded packaging, miniaturization and trends.

UNIT III  SURFACE MOUNT TECHNOLOGY  9
SMT Equipment and Material Handling Systems, Handling of Components and Assemblies - Moisture Sensitivity and ESD, Safety and Precautions Needed, IPC and Other Standards, Stencil Printing Process, solder paste storage and handling, stencils and squeegees, process parameters, quality control - Component Placement, Equipment Type, Chip shooter, IC placer, Flexibility, Accuracy of Placement, Throughput, reflow soldering, adhesive, under fill and encapsulation process, applications, storage and handling, process & parameters.

UNIT IV  SOLDERING AND CLEANING  9

UNIT V  INSPECTION, TEST AND REWORK FOR PCB  9

TOTAL: 45 PERIODS
COURSE OUTCOMES:
At the end of the course, students will be able to
CO 1: Realize wafer preparation and PCB fabrication.
CO 2: Elaborate on through hole and surface mount technology components.
CO 3: Improve knowledge on surface mount technology.
CO 4: Discuss the steps involved in soldering post solder cleaning and its importance in PCB Manufacturing.
CO 5: Locate the required inspections, testing and repair methods used in PCB.

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REFERENCES:
COURSE OBJECTIVES:
1. To impart knowledge to model and solve Integer programming problems.
2. To model and solve problems using dynamic programming.
3. To solve single- and multiple-variable unconstrained and constrained nonlinear.
4. To solve non-linear problem using KKT condition, quadratic programming and separable programming.
5. To apply meta heuristics for solving engineering problems

UNIT I INTEGER PROGRAMMING AND GOAL PROGRAMMING 9
Branch and Bound technique – cutting plane algorithm method - Traveling Salesman Problem - Branch and Bound Algorithms for TSP - Heuristics for TSP. Goal programming – Goal programming formulation - Goal programming algorithms – The weights method – Pre-emptive method

UNIT II DYNAMIC PROGRAMMING 9

UNIT III NONLINEAR PROGRAMMING I 9
Types of Nonlinear Programming Problems - One-Variable Unconstrained Optimization - Multivariable Unconstrained Optimization

UNIT IV NONLINEAR PROGRAMMING II 9

UNIT V META-HEURISTICS 9
Combinatorial optimization- NP Hard- Classification of Meta-Heuristic algorithms- Genetic Algorithm- Ant Colony Optimization- Simulated Annealing- Case studies

TOTAL: 45 PERIODS

COURSE OUTCOMES:
The students will be able to

CO1. Solve integer programming problems using appropriate methods
CO2. Solve various dynamic programming problems.
CO3. Apply methods to solve nonlinear unconstrained problems
CO4. Apply methods to solve nonlinear constrained problems.
CO5. Identify, apply and solve suitable meta-heuristic technique to solve engineering optimization problems.

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OBJECTIVES:
- To teach manufacturing issues that must be considered in the mechanical engineering design process.
- To Discuss on tools and methods to facilitate development of manufacturable mechanical designs.
- To make the students to Understand the importance of Assembly, Reliability and Quality for improving design process approach.

UNIT I  INTRODUCTION

UNIT II  SELECTION OF MATERIALS AND SHAPES

UNIT III  SELECTION OF MANUFACTURING PROCESSES

UNIT IV  DESIGN FOR ASSEMBLY

UNIT V  DESIGN FOR RELIABILITY AND QUALITY

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, students will be able to
CO 1: Understand how to formulate the need analysis leading to definition of the design problem and to convert design problem leading to embodiment design.
CO 2: Identify the suitability of materials application and manufacturing considerations
CO 3: Select manufacturing process and to consider design as per the process adopted for the design problem.
CO 4: Apply the principles of assembly to minimize the assembly time.
CO 5: Analyze and apply the concept of reliability and quality in the product design process.

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REFERENCES:

CI3053 MICRO AND NANO MANUFACTURING  
L T P C 3 0 0 3

OBJECTIVES:

- To introduce Meso, Micro and Nano manufacturing and their respective applications.
- To familiarize the students with diamond, turn machining, advanced micro machining and nano finishing methods.
- To familiarize the students with synthesis of nanomaterials and types of characterization techniques to be used.

UNIT I INTRODUCTION 9

UNIT II DIAMOND TURNING 9
Diamond turn machining-need, classification, components, material removal mechanisms, Tooling for diamond turning, Process parameters and optimization - Molecular Dynamic simulation to study nanoscale cutting-tool path strategies in surface generations- symmetric, asymmetric and freeform, applications of DTM products.

UNIT III ADVANCED MACHINING / FINISHING PROCESSES 9

UNIT IV SYNTHESIS OF NANOMATERIALS 9

UNIT V CHARACTERISATION TECHNIQUES 9

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, students will be able to
CO 1: Recognize the importance of Meso, Micro and Nano manufacturing and their respective applications.
CO 2: Elaborate on Diamond turn machining process
CO 3: Describe the advanced micro machining and nano finishing methods.
CO 4: Acquire knowledge on synthesis of nanomaterials
CO 5: Identify the type of characterization techniques to be used.

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DIRECTOR

Centre for Academic Courses
Anna University, Chennai-600 025
REFERENCES:

OBJECTIVES:
- To equip students with fundamentals of finite element analysis of manufacturing processes
- To develop finite element model for various manufacturing processes.
- To effectively use the FEA tools for solving problems in Manufacturing Engineering R&D

UNIT I  ELASTIC AND PLASTIC RELATIONS AND ISOTROPIC MATERIAL

UNIT II  PLASTICITY OF FINITE DEFORMATION AND ANISOTROPIC MATERIALS
Kinematics of Finite Deformation and Rotation - Constitutive Equation for Eulerian Formulation, Updated Lagrangian Formulation, - Anisotropic Initial Yield Criteria- Elastic-Plastic Incremental Stress-Strain - Stress-Strain Rate Relations for Anisotropic Materials.

UNIT III  EULERIAN FORMULATION OF METAL FORMING PROCESSES

UNIT IV  UPDATED LAGRANGIAN FORMULATION OF METAL FORMING PROCESSES

UNIT V  FINITE ELEMENT MODELING OF ORTHOGONAL MACHINING PROCESS
Domain - Governing Equations and Boundary Conditions for Eulerian Formulation, - Approximations for Velocity Components and Pressure- Application of boundary condition, solution procedure

COURSE OUTCOMES:
At the end of the course, students will be able to
CO 1: Develop the fundamental elastic and plastic equation used in finite element modeling of manufacturing processes
CO 2: Develop equation for plasticity of finite deformation and anisotropic
CO 3: Develop Eulerian formulation of metal forming processes
CO 4: Develop updated Lagrangian formulation of metal forming processes.
CO 5: Develop finite element modeling of orthogonal machining process

TOTAL: 45 PERIODS
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REFERENCES:

OBJECTIVES:
- To know about the need for precision engineering with its application and to understand the importance of the materials.
- To impart the knowledge about the reasons for the errors and their remedies.

UNIT I INTRODUCTION

UNIT II MATERIALS FOR PRECISION ENGINEERING

UNIT III ERRORS: CAUSES AND REMEDIES
Static stiffness - influence on machining accuracy - over all stiffness in a machine/instrument - 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 – Influence of forced is statics dimensional wear of elements - instruments; Machining tools and their influence on accuracy- error due to clamping and setting location.

UNIT IV PRECISION MACHINING

UNIT V PRECISION MACHINE ELEMENTS

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, students will be able to
CO 1: Understand the need of precision engineering and its application.
CO 2: Discuss process knowledge to use the light material / superior material as per the raising demands.
CO 3: Discuss the advanced precision machining processes.
CO 4: Explain the various errors, its causes and remedies to overcome these.
CO 5: Describe elements used in precision machine tool.
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REFERENCES:
OBJECTIVES:
- To teach the concept of system simulation and their importance in industries and the various techniques used for generating the random numbers.
- To discuss about the generation techniques and the use of the random numbers in simulation, tests, validity, verification, models of simulation and analysis.
- To train the students to solve the real time problems in the discrete systems by using a simulation software.

UNIT I  PREAMBLE TO SYSTEM SIMULATION  9
Systems, general systems theory, Functions/Relationship, concept of simulation, Stochastic activities, Types of Models, Principles used in Modeling, simulation as a decision-making tool, types of simulation, Important measures of performance, Advantages and disadvantages of simulation, Steps in simulation model building.

UNIT II  RANDOM NUMBERS  9
Methods of generating random numbers, Desirable attributes of random numbers, manual methods, computerized methods, Pseudo random numbers and random variates, discrete and continuous random probability distributions, tests for random numbers, Need for testing random numbers, Application of random numbers in simulation models

UNIT III  DESIGN OF SIMULATION  9
Problem formulation, data collection and reduction, time flow mechanism, key variables, logic flow chart, starting condition, run size, experimental design consideration, output analysis and interpretation, validation. Monte Carlo method of simulation, Manual simulation techniques

UNIT IV  SIMULATION SOFTWARE AND DATA HANDLING  9
Study and selection of simulation languages, Animation based Simulation packages, Selection of Simulation language / package, Use of any one of the simulation software for simulation model building, programmable blocks, Creation of database, Data handling and reporting, terminating conditions, Interpretation of results using statistical analysis

UNIT V  ADVANCED HEURISTICS AND AREAS OF APPLICATION  9
Ear deaf Analysis - Development of simulation models for Manufacturing and production systems, inventory optimization techniques, Advanced Sequencing and Scheduling problems, queuing systems - Problems, Heuristics for scheduling - Single pass heuristics, multipass heuristics, Evolutionary Optimization techniques - Genetic algorithm, Ant Colony algorithm, Particle Swarm optimization - Case studies.

COURSE OUTCOMES:
At the end of the course, students will be able to
CO 1: Discuss various types of systems and identify different elements of a system to build simulation models and to use them.
CO 2: Generate, test and use random numbers in different ways.

TOTAL: 45 PERIODS
CO 3: Explain various steps in building simulation models and how to run them for effective analysis of real life scenarios and obtain superior results.

CO 4: Develop capabilities of taking up consultancy projects and completing them successfully.

CO 5: Describe various cases in system simulation and its approaches

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**REFERENCES:**

OBJECTIVES:

- To expose students on the areas of competitive environment, the best manufacturing practices in the world.

UNIT I MANUFACTURING IN A COMPETITIVE ENVIRONMENT


UNIT II COMPETITIVE MANUFACTURING FOR PRODUCT DESIGN


UNIT III GROUP TECHNOLOGY & FLEXIBLE MANUFACTURING SYSTEMS


UNIT IV SIMULATION OF FLEXIBLE MANUFACTURING SYSTEMS


UNIT V COMPUTER SOFTWARE AND DATABASE OF FLEXIBLE MANUFACTURING SYSTEMS


TOTAL: 45 PERIODS

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

CO 1: Describe the areas of Competitive Environment and the best Manufacturing Practices in the World.

CO 2: Explain competitive manufacturing for product design.


CO 4: Acquaint with Simulation of Flexible Manufacturing Systems.

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REFERENCES:

OBJECTIVES:

- To provide knowledge in the areas of elastic and plastic behavior of materials, and fracture behavior of materials.
- To elaborate the theories on plastic forming and applications of advanced materials.
- To study about the selection of material.

UNIT I  ELASTIC AND PLASTIC BEHAVIOUR
Elastic, plastic and elastic and viscoelastic behavior-Mechanism of Elastic and Plastic deformation, Shear strength of perfect and real crystals - Deformation by slip and twinning, strengthening mechanism, solid solution, grain boundary, poly phase mixture, precipitation, particle, fiber and dispersion strengthening, work hardening.

UNIT II  FRACTURE BEHAVIOUR
Fracture; types of fracture, Griffith’s theory, ductile to brittle transition in steel - Fatigue of metals; strain life equation, Low and high cycle fatigue test, crack initiation and propagation mechanisms, High temperature fracture - Creep and stress rupture; High temperature alloys-Brittle-fracture problem.

UNIT III  PLASTIC FORMING OF METALS
Fundamentals of metal working, mechanics of metal working, flow-stress distribution, residual stresses, temperature in metal working- Forging in plane strain, open and closed die forging - Forces and geometrical relationships in rolling, theories of cold and hot rolling, bending and stretch forming.

UNIT IV  ADVANCED MATERIALS
Advanced high strength ferrous and non-ferrous alloys, properties and applications of engineering plastics, composite, and - Functionally gradient materials, Smart materials, Nano materials, Biomaterials

UNIT V  SELECTION OF MATERIALS
Motivation, cost basis and service requirements - Selection for mechanical properties, Selection for surface durability - Relationship between materials processing and selection - Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications

COURSE OUTCOMES:
At the end of the course, students will be able to
CO 1: Develop strengthening mechanisms.
CO 2: Analyse the fracture behavior of metals and give solutions to avoid them.
CO 3: Create processing techniques for control the plastic forming.
CO 4: Use advanced materials for new product development.
CO 5: Select materials based on industrial requirements.

TOTAL: 45 PERIODS
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REFERENCES:

OBJECTIVES:
- To understand the necessity and different design strategies in additive manufacturing.
- To study the various computational design techniques and tools to improve product development with additive manufacturing.
- To gain knowledge on polymer and metal AM design guidelines to leverage industrial applications.

UNIT I INTRODUCTION TO DESIGN FOR ADDITIVE MANUFACTURING (DfAM)


UNIT III COMPUTATIONAL TOOLS FOR AM Considerations for Analysis of AM Parts- Topology Optimization -performing analysis for weight reduction Post-processing and Interpreting Results -Applications of TO -Generative design - Generative design system and implementation -Generative design opportunities for mass-customization -Case studies.


TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, students will be able to
CO1: Gain a comprehensive understanding on design in additive manufacturing.
CO2: Acquire the ability to effectively apply design for additive manufacturing guidelines across various domains within the additive manufacturing field.
CO3: Develop the capability to optimize products and achieve optimal design outcomes.
CO4: Gain a comprehensive understanding of design guidelines for polymer additive manufacturing processes, enabling the effective utilization of these guidelines to maximize the potential applications and benefits of polymer AM technology.
CO5: Gain a comprehensive understanding of design guidelines for metal additive manufacturing processes, enabling the effective utilization of these guidelines to maximize the potential applications and benefits of Metal AM technology.
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REFERENCES:
COURSE OBJECTIVES:
1. To describe the role and drivers of supply chain management in achieving competitiveness.
2. To explain about Supply Chain Network Design.
3. To illustrate about the issues related to inventory in Supply Chain.
4. To appraise about transportation and sourcing in Supply Chain.
5. To application of Information Technology and Emerging Concepts in Supply Chain.

UNIT I INTRODUCTION TO SUPPLY CHAIN MANAGEMENT

UNIT II DISTRIBUTION NETWORK DESIGN IN SUPPLY CHAIN

UNIT III INVENTORY IN SUPPLY CHAIN
The Role of Cycle inventory in a Supply Chain, Economies of Scale to Exploit Fixed costs, Managing Multi-echelon Cycle Inventory. The Role of Safety Inventory in a Supply Chain, Determining appropriate level of Safety inventory, Impact of supply Uncertainty on Safety inventory, Impact of aggregation on safety inventory, impact of replenishment policies on safety inventory, Managing Safety Inventory in a Multi-echelon Supply Chain, The Role of IT in inventory management.

UNIT IV TRANSPORTATION AND SOURCING IN SUPPLY CHAIN
The role of transportation in a Supply chain, Modes of transportation and their performance characteristics, Transportation infrastructure and policies, Design options for a transportation network, Trade-offs in transportation design, Tailored transportation, The role of IT in transportation, Problems. Sourcing Decisions In A Supply Chain: The role of sourcing in a supply chain, in-house or outsource, Third-and Fourth-party logistics providers, Total cost of Ownership, Supplier selection, Auctions and Negotiations, Sharing Risk and Reward in the supply chain.

UNIT V INFORMATION TECHNOLOGY IN SUPPLY CHAIN
The role of IT in a supply chain, The supply chain IT framework, The supply chain macro processes, Lack of Supply Chain co-ordination and the Bullwhip effect, managerial levers to achieve coordination, continuous replenishment and vendor-managed inventories, collaborative planning, forecasting and replenishment (CPFR).

TOTAL: 45 PERIODS
COURSE OUTCOMES:
The students will be able to

CO1. Understand supply chain concepts, systemic and strategic role of SCM in global competitive environment.
CO2. Evaluate alternative supply and distribution network structures using optimization models.
CO3. Develop optimal inventory policies in the supply chain context.
CO4. Develop optimal sourcing and Transportation decisions in the supply chain.
CO5. Select appropriate information technology frameworks for managing supply chain processes.

REFERENCES:

CO's-PO's & PSO's MAPPING

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COURSE OBJECTIVES

1. To understand Lean production principles, eliminate waste, and improve efficiency through case studies.
2. To learn steps for Value Stream Mapping, apply Lean metrics, and implement improvements in value streams.
3. To explore Six Sigma's relationship with Lean Manufacturing, cultural changes, quality assessment, and cost implications.
4. To gain knowledge of various Six Sigma tools and techniques for problem-solving and project management.
5. To evaluate Six Sigma quality economics, focus on continuous improvement using Lean principles, Kaizen, and 5S methodologies.

UNIT I LEAN MANUFACTURING

UNIT II VALUE STREAM MAPPING
Need for Value Stream mapping; Steps involved in Value stream mapping – Choose value stream – PQ and PR analysis, Current State map, Lean Metrics, Future State Map, Kaizen plans; Lean implementation - Cultural change, Hoshin planning; Lean in the Supply chain.

UNIT III SIX SIGMA
Six sigma - lean manufacturing and six sigma- six sigma and process tolerance – Six sigma and cultural changes – six sigma capability – six sigma need assessments - implications of quality levels, Cost of Poor Quality (COPQ)

UNIT IV SIX SIGMA SCOPE OF TOOLS AND TECHNIQUES

UNIT V EVALUATION AND CONTINUOUS IMPROVEMENT METHODS
Evaluation strategy – the economics of six sigma quality, Return on six Sigma (ROSS), ROI, poor project estimates – continuous improvement – lean manufacturing – value, customer focus, Perfection, focus on waste, overproduction – waiting, inventory in process (IIP), processing waste, transportation, motion, making defective products, underutilizing people – Kaizen – 5S

TOTAL: 45 PERIODS
**COURSE OUTCOMES:**
The students will be able to

| CO1. | Demonstrate understanding of Lean production principles, waste identification, and efficiency improvement. |
| CO2. | Apply Value Stream Mapping steps and Lean metrics to enhance organizational performance. |
| CO3. | Analyze the relationship between Six Sigma and Lean Manufacturing, evaluate cultural changes, quality levels, and cost implications. |
| CO4. | Acquire knowledge of Six Sigma tools and techniques for effective problem-solving and project management. |
| CO5. | Evaluate Six Sigma quality economics and demonstrate commitment to continuous improvement through Lean principles, Kaizen, 5S methodologies, and customer focus. |

**REFERENCES:**
3. Fred Soleimannejed, Six Sigma, Basic Steps and Implementation, AuthorHouse, 2004

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1-low, 2-medium, 3-high, ‘-‘- no correlation

[Signature]

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025
OBJECTIVES:
- Describe an idea about ERP and extended modules of ERP
- Extract knowledge of ERP implementation cycle and effects of ERP after its implementation
- Understanding the emerging trends on ERP

UNIT I  OVERVIEW OF ERP SYSTEMS  
Overview of enterprise systems – Evolution - Risks and benefits - Fundamental technology - Issues to be consider in planning design and implementation of cross functional integrated ERP systems.

UNIT II  ERP SOLUTIONS AND FUNCTIONAL MODULES  
Overview of ERP software solutions- Small, medium and large enterprise vendor solutions, BPR, and best business practices - Business process Management, Functional modules-Management Information system - Executive information system - Decision support system - Business Intelligence for ERP systems.

UNIT III  ERP IMPLEMENTATION  
Planning Evaluation and selection of ERP systems - Implementation life cycle - ERP implementation- transition strategies - Methodology and Frame work- Training – Data Migration. People Organization in implementation-Case studies-Consultants, Vendors and Employees- Case studies in ERP implementation

UNIT IV  POST IMPLEMENTATION  
Maintenance of ERP- Organizational and Industrial impact; Success and Failure factors of ERP Implementation- Operation and Maintenance of an ERP system - ERP Audit-Case studies.

UNIT V  EMERGING TRENDS ON ERP  

COURSE OUTCOMES:
At the end of the course, students will be able to
CO 1: Get an idea about ERP
CO 2: Awareness of core and extended modules of ERP
CO 3: Knowledge of ERP implementation cycle.
CO 4: Gain knowledge about effects of ERP after its implementation.
CO 5: Understand the emerging trends on ERP.

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REFERENCES:
COURSE OBJECTIVES:
1. To understand industrial automation principles and strategies.
2. To evaluate the material handling system used in the automated industries.
3. To understand the working of industrial robots and its sensors.
4. To gain knowledge in the kinematics of robotic manipulators.
5. To gain knowledge in the dynamics of robotic manipulators.

UNIT I INTRODUCTION

UNIT II MATERIAL HANDLING SYSTEM
Concepts of material handling, principles and considerations in material handling systems design, conventional material handling systems - industrial trucks, rail guided vehicles, conveyor systems - advanced material handling systems - automated guided vehicle systems - automated storage and retrieval systems (ASRS), Work-in-process Storage - Interfacing Handling and Storage with Manufacturing.

UNIT III ROBOTS AND SENSORS

UNIT IV KINEMATICS OF ROBOTIC MANIPULATORS

UNIT V DYNAMICS OF ROBOTIC MANIPULATORS

TOTAL: 45 PERIODS
COURSE OUTCOMES:

The students will be able to

**CO1.** Describe the industrial automation principles and strategies.

**CO2.** Evaluate the material handling system for automation.

**CO3.** Distinguish between different sensors for different applications.

**CO4.** Demonstrate the Kinematics of Robotic Manipulators.

**CO5.** Demonstrate the Dynamics of Robotic Manipulators.

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OBJECTIVES:
- Understand the concept of sustainable manufacturing and its importance in today's global context.
- Identify the environmental, economic, and social impacts of manufacturing processes and products.
- Explore sustainable manufacturing practices, tools, and strategies used in different industries.

UNIT I  ECONOMIC SUSTAINABILITY
- Industrial Revolution
- Economic sustainability: globalization and international issues
- Sustainability status
- Competitive manufacturing strategies
- Performance evaluation
- Management for sustainability
- Assessments of economic sustainability
- Government regulations for sustainability

UNIT II  SOCIAL AND ENVIRONMENTAL SUSTAINABILITY
- Social sustainability
- Introduction
- Work management
- Human rights
- Societal commitment
- Customers
- Business practices
- Modelling and assessing social sustainability
- Environmental issues pertaining to the manufacturing sector
- Pollution
- Use of resources
- Pressure to reduce costs
- Environmental management
- Processes that minimize negative environmental impacts
- Environmental legislation and energy costs
- Carbon footprint: calculation, need to reduce the carbon footprint of manufacturing Operations
- Carbon trading and offsetting
- Modelling and assessing environmental sustainability

UNIT III  SUSTAINABILITY PRACTICES
- Sustainability awareness
- Measuring Industry Awareness
- Drivers and barriers
- Availability of sustainability indicators
- Analysis of sustainability practicing
- Modelling and assessment of sustainable practicing
- Sustainability awareness
- Sustainability drivers and barriers
- Availability of sustainability indicators
- Designing questionnaires
- Optimizing Sustainability Indexes
- Elements
- Cost and time model
- Government regulations for Sustainable Manufacturing

UNIT IV  MANUFACTURING STRATEGY FOR SUSTAINABILITY
- Concepts of competitive strategy
- Manufacturing strategies
- Development of a strategic improvement programme
- Manufacturing strategy in business success
- Strategy formulation
- Structured strategy formulation
- Sustainable manufacturing system design options
- Approaches to strategy formulation
- Realization of new strategies/system designs
- Design for Environment (DfE) principles and frameworks
- Life cycle assessment (LCA)
- Resource efficient design
- Design for disassembly and recyclability

UNIT V  TRENDS IN SUSTAINABLE OPERATIONS
- Principles of sustainable operations
- Process analysis
- Capacity management
- Quality management
- Inventory management
- Just-In-Time systems
- Circular economy principles and strategies
- Product life extension and remanufacturing
- Closed-loop supply chains and reverse logistics
- Sustainable sourcing and procurement practices
- Green logistics and transportation in supply chains
- Recycling and reuse techniques for manufacturing waste
- Energy-efficient technologies and practices in manufacturing
- Case studies on renewable energy implementation in manufacturing
- Net Zero Emission
- Consumerism and sustainable well-being

TOTAL: 45 PERIODS
COURSE OUTCOMES:
At the end of the course, students will be able to
CO 1: Discuss the importance of economic sustainability.
CO 2: Describe the importance of sustainable practices.
CO 3: Identify drivers and barriers for the given conditions.
CO 4: Formulate strategy in sustainable manufacturing.
CO 5: Plan for sustainable operation of industry with environmental, cost consciousness.

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REFERENCES:
OBJECTIVES:
● Understand the fundamentals of sensors and their importance in condition monitoring.
● Learn about various types of sensors and their working principles.
● Explore the applications of sensors in monitoring the health and performance of machines and systems.

UNIT I  INTRODUCTION TO SENSORS AND CONDITION MONITORING
Role of sensors in manufacturing and condition monitoring – measurement of positions, displacement, angles, mechanical, fluidic, thermal, imaging – Principles – Classification – Direct and indirect methods – Applications — Basic requirements of sensor – Signal processing and decision making - Reactive, Preventive, Predictive Maintenance.

UNIT II  SENSORS FOR WORKPIECE MONITORING
Mechanical, Electrical, Electro-mechanical, Opto-electrical, Optical, Pneumatic, Capacitance, Eddy- current and Magnetic sensors – Case Studies.

UNIT III  SENSORS FOR MACHINE TOOL MONITORING

UNIT IV  SENSORS FOR MACHINING PROCESSES

UNIT V  ADVANCED SENSORS AND CONDITION MONITORING METHODS

COURSE OUTCOMES:
At the end of the course, students will be able to
CO 1: Recognize the importance of sensors and condition monitoring in manufacturing.
CO 2: Identify suitable sensors for monitoring workpiece during machining operation.
CO 3: Identify suitable sensors for monitoring machine tool during machining operation.
CO 4: Identify suitable sensors in monitoring the machining process.
CO 5: Perceive the usage and importance of advanced sensors in manufacturing industries.

TOTAL: 45 PERIODS
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REFERENCES:

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


UNIT II  SENSORS AND TRANSDUCERS


UNIT III  DRIVES AND ACTUATORS


UNIT IV  MICROPROCESSORS AND MICROCONTROLLERS


UNIT V  INTEGRATION OF MANUFACTURING SYSTEMS


TOTAL : 45 PERIODS
COURSE OUTCOMES:
Upon successful completion of the course, students should be able to

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<td>Recall and identify key concepts in mechatronics for modern manufacturing.</td>
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<td>Describe the principles and relationships of mechatronic system elements in manufacturing processes.</td>
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<td>CO3</td>
<td>Apply knowledge of sensors, transducers, drives, and actuators to design and troubleshoot mechatronic systems.</td>
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<td>Analyze and evaluate the performance of mechatronic components for process optimization.</td>
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<tr>
<td>CO5</td>
<td>Design and integrate mechatronic systems for manufacturing automation.</td>
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REFERENCES:

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