ANNA UNIVERSITY, CHENNAI
NON- AUTONOMOUS COLLEGES AFFILIATED ANNA UNIVERSITY
M.E. COMPUTER INTEGRATED MANUFACTURING
REGULATIONS - 2021
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULAR AND SYLLABI

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

1. To train students to independently carry out research / investigations and development work to solve practical problems.
2. To train students to write and present a technical report/ documents.
3. To train students to demonstrate mastery in the area of computer integrated manufacturing at a higher level.
4. 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.
5. To train students to provide solutions to industrial/research problems considering economic, environmental and social contexts for sustainable development.
6. To train students to solve technical problems with creativity, innovation, confidence and self-responsibility.

2. PROGRAMME OUTCOMES (POs):

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

**PO 1:** Ability to independently carry out research / investigations and development work to solve practical problems.

**PO 2:** Ability to write and present a substantial technical report/ documents.

**PO 3:** Ability to demonstrate mastery in the area of computer integrated manufacturing at a higher level.

**PO 4:** Ability 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.

**PO 5:** Ability to provide solutions to industrial/research problems considering economic, environmental and social contexts for sustainable development.

**PO 6:** Ability to solve technical problems with creativity, innovation, confidence and self-responsibility.
# PROGRAM ARTICULATION MATRIX

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2
### M.E. COMPUTER INTEGRATED MANUFACTURING

#### REGULATIONS 2021

#### CHOICE BASED CREDIT SYSTEM

#### I TO IV SEMESTERS CURRICULA AND SYLLABUS

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COURSE OBJECTIVES:
1. To understand the basics of random variables with emphasis on the standard discrete and continuous distributions.
2. To understand the basic probability concepts with respect to two dimensional random variables along with the relationship between the random variables.
3. To apply the small and large sample tests through test of hypothesis.
4. To understand the basic concepts of sampling distributions and statistical properties of point estimators.
5. To understand the concept of analysis of variance and use it to investigate factorial dependence.

UNIT I PROBABILITY AND RANDOM VARIABLES

UNIT II TWO DIMENSIONAL RANDOM VARIABLES
Joint distributions – Marginal and conditional distributions – Functions of two dimensional random variables – Regression curve – Correlation.

UNIT III TESTING OF HYPOTHESIS
Sampling distributions - Type I and Type II errors - Tests based on Normal, t, Chi square and F distributions for testing of mean, variance and proportions – Tests for independence of attributes and goodness of fit.

UNIT IV ESTIMATION THEORY
Interval estimation for population mean - Standard deviation - Difference in means, proportion ratio of standard deviations and variances.

UNIT V DESIGN OF EXPERIMENTS
Completely randomized design – Randomized block design – Latin square design – $2^2$ Factorial design.

COURSE OUTCOMES:
At the end of the course, students will be able to
1. Analyze the performance in terms of probabilities and distributions achieved by the determined solutions.
2. Be familiar with some of the commonly encountered two dimensional random variables and be equipped for a possible extension to multivariate analysis.
3. Apply the basic principles underlying statistical inference(hypothesis testing).
4. Demonstrate knowledge of applicable large sample theory of estimators and tests.
5. Obtain a better understanding of the importance of the methods in modern industrial processes.

REFERENCES:
COURSE OBJECTIVES:

- To understand fundamental concepts of computer graphics and its tools in a generic framework.
- To impart the parametric fundamentals to create and manipulate geometric models using curves, surfaces and solids.
- To impart the parametric fundamentals to create and manipulate geometric models using NURBS 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  9
Geometric Transformations: Coordinate Transformations, Windowing and Clipping, 2D Geometric transformations-Translation, Scaling, Shearing, Rotation and Reflection, Composite transformation, 3D transformations.

UNIT – II  CURVES AND SURFACES MODELLING  9
Introduction to curves - Analytical curves: line, circle and conics – synthetic curves: Hermite cubic spline- Bezier curve and B-Spline curve – curve manipulations.

UNIT – III  NURBS AND SOLID MODELING  9

UNIT – IV  VISUAL REALISM  9
Animation - Conventional, Computer animation, Engineering animation - types and techniques.

UNIT – V  ASSEMBLY OF PARTS AND PRODUCT LIFE CYCLE MANAGEMENT  9

TOTAL: 45 PERIODS
COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Solve 2D and 3D transformations for the basic entities like line and circle.
2. Formulate the basic mathematics fundamental to CAD system.
3. Use the different geometric modeling techniques like feature based modeling, surface modeling and solid modeling.
4. Create geometric models through animation and transform them into real world systems

REFERENCES:

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CM4151 COMPUTER AIDED MANUFACTURING L T P C 3 0 0 3

COURSE 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.
- To impart knowledge on manual part program and generation of CNC part program using Computer Aided Manufacturing packages.
- To introduce with the implementation of CAD and CAM in manufacturing process.
- To introduce the importance of Internet of Things in Computer Aided Manufacturing.
UNIT I  INTRODUCTION TO CAM  9
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 standard, interpreting geometric specifications, multiple part features and datum.

UNIT II  CAD AND CAM INTEGRATION  9

UNIT III  PROGRAMMING OF CNC MACHINES  9
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, wire electric discharge machining, abrasive water jet cutting machine, bulk and sheet metal forming, generation of CNC program using CAM softwares.

UNIT IV  CAD AND CAM FOR MANUFACTURING PROCESSES  9
Classification of Manufacturing process, construction and operations, Integration of CAD and CAM in CNC turning center, machining center, electric discharge machining, wire electric discharge machining, abrasive water jet cutting machine, bulk forming, sheet metal forming.

UNIT V  IOT IN CAM  9
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 this course, the students shall be able to:
CO1: Recognize the importance of CAD, CAM, CIM, Engineering product specification and interpreting geometric specifications.
CO2: Improve knowledge on the integration of CAD and CAM.
CO3: Exhibit competency in manual part program and generation of CNC part program using CAM packages.
CO4: Describe the implementation of CAD and CAM in manufacturing processes.
CO5: Explain applications of IOT in computer aided manufacturing.

REFERENCES:
CM4152  SOLID FREEFORM MANUFACTURING  L T P C
            3 0 0 3

COURSE OBJECTIVES:

- To acquaint the students with evolution of Solid Freeform Manufacturing (SFM) / Additive Manufacturing (AM), proliferation into various fields and its effects on supply chain.
- To gain knowledge on Design for Additive Manufacturing (DFAM) and its importance in quality improvement of fabricated parts.
- To acquaint with polymerization and sheet lamination processes and their applications.
- To acquaint with material extrusion and powder bed fusion processes.
- To gain knowledge on jetting and direct energy deposition processes and their applications.

UNIT I  INTRODUCTION

UNIT II  DESIGN FOR ADDITIVE MANUFACTURING

UNIT III  VAT POLYMERIZATION AND SHEET LAMINATION PROCESSES
UNIT IV  MATERIAL EXTRUSION AND POWDER BED FUSION PROCESSES


UNIT V  JETTING AND DIRECT ENERGY DEPOSITION PROCESSES


COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Relate the importance in the evolution of SFM/AM, proliferation into the various fields and its effects on supply chain.
CO2: Analyze the design for AM and its importance in the quality of fabricated parts.
CO3: Build knowledge on principles and applications of polymerization and sheet lamination processes with case studies.
CO4: Explain the principles of material extrusion and powder bed fusion processes and design guidelines.
CO5: Elaborate jetting and direct energy deposition processes and their applications.

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UNIT I  RESEARCH DESIGN  6
Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II  DATA COLLECTION AND SOURCES  6
Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

UNIT III  DATA ANALYSIS AND REPORTING  6
Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

UNIT IV  INTELLECTUAL PROPERTY RIGHTS  6

UNIT V  PATENTS  6

REFERENCES

TOTAL : 30 PERIODS

CM4101  INDUSTRIAL ROBOTICS  L T P C
3 0 0 3

COURSE OBJECTIVES:
- To teach students the basics of robotics, construction features, sensor applications, robot cell design, robot programming and application of artificial intelligence and expert systems in robotics.

UNIT I  INTRODUCTION AND ROBOT KINEMATICS  10

UNIT II  ROBOT DRIVES AND CONTROL  9
UNIT III   ROBOT SENSORS

UNIT IV   ROBOT CELL DESIGN AND APPLICATION

UNIT V   ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS

TOTAL: 45 PERIODS

COURSE OUTCOMES:
The student will be able to design robots and robotic work cells and write program for controlling the robots. The student will be able to apply artificial intelligence and expert systems in robotics.

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COURSE OBJECTIVES:
- To familiarize the students with CAD and CAE modules.
- To create basic sketches and to design part modelling for the given mechanical components.
- To generate assemblies from the part model with respect to the constraints and to various data exchange formats.
- To familiarize the students with reverse engineering as a tool to create 3D models for 3D printing.
- To gain practical knowledge in CAE module through Finite Element Analysis.

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.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Apply knowledge on CAD and CAE modules.
CO2: Build and design interactive CAD models.
CO3: Interpret the given mechanical components and to design for 3D printing.
CO4: Demonstrate the use of FEA package.
CO5: Make use of assemble parts, evaluate the information and resources using FEA.

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

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COURSE OBJECTIVES:
• To familiarize students with manual CNC part programming for milling and turning machines.
• To generate 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 and robot programming.
• To introduce the concept of printing parts using additive manufacturing and to introduce Relational database management system in 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

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Explain the manual CNC part programming for milling and turning machines.
CO2: Create part programs using CAM packages for milling and turning Machines.
CO3: Appraise dimensional and geometric measurements of machined features using video measuring system and coordinate measuring machine.
CO4: Construct PLC ladder programming and robot programming.
CO5: Relate the concept of printing parts using additive manufacturing and appreciate the application RDBMS in MRP.

LIST OF EQUIPMENTS 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. RDMBS Package with relevant modules like Inventory Control and MRP
10. 3D Printer

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COURSE OBJECTIVES:
- To teach the concepts of metrology.
- To train the students in various aspects of measurement of surface roughness.
- To train the students in the area of interferometry and form measurements.
- To train the students with understanding the fundamental principles of computer aided inspection and laser metrology.
- To introduce the basic principles of image processing and machine vision in context to metrological applications.

UNIT I  CONCEPTS OF METROLOGY  9

UNIT II  MEASUREMENT OF SURFACE ROUGHNESS  9

UNIT III  INTERFEROMETRY  9

UNIT IV  COMPUTER AIDED INSPECTION AND LASER METROLOGY  9

UNIT V  MACHINE VISION AND IMAGE PROCESSING  9

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Illustrate the fundamental concepts of measurement, standards, calibration, maintenance of laboratory facilities and handling of metrological equipments.
CO2: Explain the roughness and its applications in manufacturing research, learn the important concepts, principles and applications related to interferometry.
CO3: Justify the use of interferometry related sophisticated measurement and inspection facilities.
CO4: Relate the concepts of Computer aided inspection technologies for industrial Situations, design and develop new inspection techniques.
CO5: Discuss the importance of image processing techniques and the possibilities of developing new heuristics for image processing related to metrology.
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REFERENCES:


CM4202 MANUFACTURING PLANNING AND CONTROL SYSTEMS

OBJECTIVES:

- To introduce students with Current Trends in Manufacturing Planning and Control System and Forecasting activities.
- To impart basic concepts of Aggregate Production Planning.
- To elaborate on Inventory management and Resource Requirements.
- To be familiarized with the functions of Shop Floor Control and associated systems.

UNIT I MANUFACTURING PLANNING AND CONTROL AND FORECASTING

Introduction: Production Planning and Control-Limitations with Traditional Production Planning and Control-Need and Evolution of Manufacturing Planning and Control (MPC) System -Basic framework -Demand Management in MPC System- Forecasting: Time Horizon, Design of Forecasting Systems -Developing the Forecast Logic– Qualitative methods: Delphi Technique, Market Research, Quantitative methods -Time Series - Moving Averages, Exponential Smoothing -Regression- Measure of Forecast Accuracy- Numerical Problems

UNIT II AGGREGATE PRODUCTION PLANNING

UNIT III RESOURCE PLANNING 9

UNIT IV SHOP FLOOR CONTROL 9
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 9

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Evaluate the various activities of Manufacturing Planning and Control System and Forecasting activities.
CO2: Outline the concepts of Aggregate Production Planning.
CO3: Organize the Inventory management and Resource Requirements.
CO4: Develop the functions of Shop Floor Control and associated systems.

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REFERENCES
CM4203  COMPETITIVE MANUFACTURING SYSTEMS  L T P C

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COURSE OBJECTIVES:
• To expose students on the areas of competitive environment, the best manufacturing practices in the world.
• To impart the concepts of group technology and flexible manufacturing systems.
• To gain knowledge in simulation techniques of flexible manufacturing systems.
• To outline computer software and database of flexible manufacturing systems.
• To familiarize the principles of just in time manufacturing systems.

UNIT I  MANUFACTURING IN A COMPETITIVE ENVIRONMENT  9

UNIT II  GROUP TECHNOLOGY & FLEXIBLE MANUFACTURING SYSTEMS  9

UNIT III  SIMULATION OF FLEXIBLE MANUFACTURING SYSTEMS  9

UNIT IV  COMPUTER SOFTWARE AND DATABASE OF FLEXIBLE MANUFACTURING SYSTEMS  9

UNIT V  JUST IN TIME MANUFACTURING SYSTEMS  9

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Describe the areas of Competitive Environment and the best Manufacturing Practices in the World.
CO3: Acquaint with Simulation of Flexible Manufacturing Systems.
CO5: Explain Just in Time Manufacturing Systems.
REFERENCES:
5. Taiichi Ohno, Toyota, " Production System Beyond Large-Scale production Productivity Press (India) Pvt.Ltd. 1992

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CM4204 MECHATRONICS IN MANUFACTURING SYSTEMS L T P C
3 0 0 3

COURSE OBJECTIVES:
- To provide overview of various electrical and electronic control techniques used in modern manufacturing systems.
- To know the basic working principle of sensors and transducers of use for manufacturing systems
- To know the basic working principle of drives and actuators of use for manufacturing systems
- To know the features, modules and interfaces of microcontrollers and microprocessors
- To gain the knowledge of integration of mechatronic systems in automation of modern manufacturing systems

UNIT I INTRODUCTION TO MECHATRONICS IN MODERN MANUFACTURING

UNIT II SENSORS AND TRANSDUCERS 8

UNIT III DRIVES AND ACTUATORS 8

UNIT III MICROPROCESSORS AND MICROCONTROLLERS 8

UNIT V INTEGRATION OF MANUFACTURING SYSTEMS 9

COURSE OUTCOMES:
Students will be able to
CO1 : Imply the knowledge to study the mechatronics in modern manufacturing systems.
CO2 : Identify and select the sensors and transducers based on the application.
CO3 : Identify the principles and functions of drives and actuators.
CO4 : Get knowledge of microprocessor and microcontrollers and its functions.
CO5 : Apply the knowledge about integration of mechatronic systems in manufacturing.

REFERENCES:
1. Beno Benhabib, Manufacturing, design, production, automation and integration, Marcel Dekker, 2003

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COURSE OBJECTIVES:
- To introduce the practical applications of various measurement concepts.
- To gain knowledge on the design perspective of advanced measuring machines.
- To make the students understand the fundamental principles of measuring techniques by practicing exercises on various measuring instruments.
- To perform metallographic study of the given samples and heat treatment study of steel.
- To familiarize the importance of measurement and inspection in manufacturing industries.

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.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Demonstrate sophisticated measuring machines with ease.
CO2: Improve the confidence in developing of new concepts and new measuring machines.
CO3: Develop various technical terms and perform measurement tasks accurately.
CO4: Identify the right instrument and method of measurement for a particular Application.
CO5: Apply the fundamental concepts of measurements, standards, calibrations, maintenance of laboratory facilities and handling of equipment's.

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COURSE OBJECTIVE:

- To design and test hydraulic, Pneumatic circuits using any compatible software.
- To design and simulate fluid power actuator circuit using software tools.
- To simulate hydraulic and Pneumatic circuits using automation studio/any compatible software.
- To make different types of robots and demonstrate them to identify different robot and for different applications.
- To write robot programming for simple operations.

List of Experiments:
1. System control using PID controllers.
2. Control of actuator using Hydrosim/Phenumsim/ Equivalent software.
3. Design and simulation of two pneumatic circuits using compatible software
5. Design and simulation of two PLC based circuits (Ladder Diagram) using compatible software.
6. Two PLC based circuit and execute on experiment kit.
7. Robot programming and simulation for shape identification.
8. Robot programming and simulation for any industrial process (Packing, Assembly)
9. Robot programming and simulation for colour identification.
10. Robot programming and simulation for pick and place robot.

Course Outcome:
CO 1: Design and simulate Pneumatic, Electro –Pneumatic and PLC based circuits on compatible software.
CO 2: Model the PLC based circuits on experimental kit.
CO 3: Demonstrate PLC Ladder and robot programming.
CO 4: Evaluate any robotic simulation software to make different types of robot and calculate work volume for different robot.
CO 5: Make use of different types of robots and demonstrate them to identify different parts and components.

List of equipment required:
1. Computer -30 Nos
2. Hydraulic trainer kit with accessories
3. Pneumatic trainer kit accessories
4. PLC interface card
5. Hydraulic/ Pneumatic circuit simulation compatible software
6. Robot operating system
7. Pick and Place robot.

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CM4311  
**PROJECT WORK I**  

**COURSE 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 this course, the students shall be able to:
CO1: Apply the knowledge gained from theoretical and practical courses in solving problems.
CO2: Recognize the importance of literature review.
CO3: Realize the importance of solving problems using literature review.
CO4: Recognize the modern concepts in technology and design.
CO5: Develop skills to read, write and comprehend.

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CM4411  
**PROJECT WORK II**  

**COURSE 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 this course, the students shall be able to:
CO1: Apply the knowledge gained from theoretical and practical courses in solving problems.
CO2: Build strong working knowledge of ethics and professional responsibility.
CO3: Demonstrate effective organizational leadership and change skills.
CO4: Evaluate the importance of solving problems using literature review.
CO5: Develop skills to read, write and comprehend.

TOTAL: 360 PERIODS
CM4001 ADVANCES IN MANUFACTURING TECHNOLOGY  L T P C 3 0 0 3

COURSE OBJECTIVES:
- To interpret and compare different non-traditional machining processes.
- To recognize different precision machining processes.
- To interpret modern metal forming processes.
- To differentiate between micromachining and microfabrication.
- To formulate smart manufacturing systems.

UNIT I UNCONVENTIONAL MACHINING 9

UNIT II PRECISION MACHINING 9

UNIT III MODERN METAL FORMING 9

UNIT IV MICRO MACHINING AND MICRO FABRICATION 9

UNIT V INDUSTRY 4.0 9
Introduction - Industry 4.0 – Smart manufacturing: Smart design, smart machining, smart monitoring, smart control, smart scheduling - Internet of Things - Industrial Internet of Things - Framework: Connectivity devices and services - Intelligent networks of manufacturing - Cloud computing - Data analytics - Cyber physical systems - Machine to Machine communication - case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
- CO1: Classify different non-traditional machining processes.
- CO2: Identify the different precision machining processes.
- CO3: Explain the modern metal forming processes.
- CO4: Interpret different micro machining and micro fabrication techniques.
- CO5: Demonstrate the Industry 4.0 and smart manufacturing system concepts.
REFERENCES:

CM4002 COMPUTER AIDED PROCESS PLANNING

OBJECTIVES:
- To familiarize the students with the basics of process planning.
- To introduce the part representation methods and approaches
- To acquaint the students with knowledge in process metrics and capabilities
- To gain knowledge on Logical Design of Process Planning
- To impart knowledge on the types of computer aided process planning systems

UNIT I INTRODUCTION:
Production Planning and Process Planning - The role of Process Planning in the Manufacturing cycle - Experience based planning - Need for computer aided process planning. – Process Planning and Concurrent Engineering, Group Technology

UNIT II PART DESIGN REPRESENTATION
Basic part representation methods: CAD models-Feature based design-Design interface: syntactic pattern recognition-State transition diagram-Decomposition approach-Logic approach-Graph based approach.

UNIT III KNOWLEDGE REPRESENTATION

UNIT IV SYSTEM FORMULATION

UNIT V COMPUTER AIDED PROCESS PLANNING SYSTEMS
Computer aided Process Planning – Variant process planning – Generative process planning– Forward and Backward planning, input format - Totally Integrated process planning systems – Expert process planning-Commercial systems: CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP

TOTAL: 45 PERIODS
OUTCOMES:
At the end of this course students shall be able to:
CO1: Elaborate on the basics of process planning.
CO2: Demonstrate competency in part representation methods and approaches
CO3: Recognize the importance of process metrics and capabilities
CO4: Elaborate on Logical Design of Process Planning
CO5: To impart knowledge on the types of computer aided process planning systems

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CM4003 DESIGN FOR MANUFACTURING

- To impart the knowledge in design for manufacturing and assembly (DFM/A) principles.
- To be acquainted with the use of DFM/A tools.
- To elaborate DFM/A system architecture.
- To outline product model and interfacing.
- To discuss system implementation by considering various manufacturing constraints.

UNIT I INTRODUCTION
Implementation of concurrent engineering- Issues involved in introducing design for manufacturing and assembly (DFM/A)- DFM/A principles and techniques - Current state of commercial DFM/A packages- Requirements for a new generation of DFM/A Systems - Knowledge-based approaches to DFM/A- Interfacing design (CAD) and DFM/A Systems, Case studies.

UNIT II DFM/A METHODOLOGIES
Total design Environment-Tools: Quality function deployment, Failure modes and effects analysis (FMEA)- Design for manufacturing and assembly principles: Mechanical Assembly- General DFA principles- DFA guidelines: General mechanical, General electro-mechanical - Design for manual assembly- Design for electronics Assembly-Design for Testability-Machining- Currently available manufacturability analysis tools- Integrating DFM/ A into different design regimes - Case studies
UNIT III DFM/A SYSTEM ARCHITECTURE

UNIT IV PRODUCT MODEL AND CAD INTERFACING
Product Model - Structure and object - Oriented Approach-Classes and objects - Polymorphism and inheritance - Modelling concepts- Product model structure overview- Detailed product model- Storage of object-Oriented product models - Features in CAD-DFM integration - Feature representation methodologies- Classification of features -Hierarchical structure of the features -Interfacing with different CAD systems - Interface mechanisms for applications-knowledge engineering and inferencing

UNIT V SYSTEM IMPLEMENTATION
System for design for PCB assembly, small parts assembly, mechanical assembly, machining Generic architecture operational aspects- Architecture realization- Control module

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the End of the Course, the students will be able to
CO1: Describe the design for manufacturing principles.
CO2: Implement DFM/A principles in the required applications.
CO3: Use DFM/A tools.
CO4: Select appropriate DFM/A system architecture with the given manufacturing aspects.
CO5: Create Product model.

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CM4004 DESIGN OF CELLULAR MANUFACTURING SYSTEM

OBJECTIVES:
1. To introduce the concept of group technology
2. To expose students to planning and design of cellular manufacturing system
3. To impart knowledge on implementation of group technology/ cellular manufacturing systems
4. To outline the concept of performance measurement and control of GT/CMS
5. To gain knowledge on economics of GT/CMS
UNIT I 
INTRODUCTION: 
Introduction to Group Technology, Limitations of traditional manufacturing systems, characteristics and design of groups, benefits of GT and issues in GT.

UNIT II 
CMS PLANNING AND DESIGN: 

UNIT III 
IMPLEMENTATION OF GT/CMS: 
Inter and Intra cell layout, cost and non-cost based models, establishing a team approach, Managerial structure and groups, batch sequencing and sizing, life cycle issues in GT/CMS.

UNIT IV 
PERFORMANCE MEASUREMENT AND CONTROL: 
Measuring CMS performance - Parametric analysis - PBC in GT/CMS, cell loading, GT and MRP - framework.

UNIT V 
ECONOMICS OF GT/CMS: 
Conventional Vs group use of computer models in GT/CMS, Human aspects of GT/CMS - cases.

TOTAL: 45 PERIODS

OUTCOMES:
At the end of this course, the students shall be able to
CO1: Perceive the concept of group technology
CO2: Understand the planning and design of CMS
CO3: Gain knowledge on implementation of GT/CMS
CO4: Analyse the performance measurement and control of GT/CMS
CO5: Describe the economics of GT/CMS

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OBJECTIVES:
- To equip students with fundamentals of finite element principles.
- To impart knowledge on solving 2 dimensional finite element problems.
- To develop finite element model for the field problems.
- To introduce non-linear analysis and its computational methods.
- To emphasis on the finite element approach of production processes.

UNIT I GENERAL INTRODUCTION

UNIT II PROBLEM IN 2D:

UNIT III APPLICATIONS TO FIELD PROBLEMS
Higher Order Elements. Natural co-ordinate systems – Isoparametric elements – Shape functions for isoparametric elements – One, two and three dimensions – Serendipity elements – Numerical integration and application to plane stress problems transformation in $\xi, \eta$ and $\zeta$ – coordinates- Jacobian of transformation-order of convergence- numerical integration –example problems- shape functions in natural coordinates- rectangular elements- Lagrange family- Serendipity family- rectangular prisms-tetrahedral elements

UNIT IV NON-LINEAR ANALYSIS
Introduction to Non-linear problems - some solution techniques- computational procedure- simple material nonlinearity- Plasticity and viscoplasticity, stress stiffening, contact interfaces- problems of gaps and contact- geometric non-linearity- modeling considerations- Impact analysis.

UNIT V ANALYSIS OF PRODUCTION PROCESSES
Application to Bulk forming, sheet metal forming, casting, metal cutting, welding- Features of software packages

OUTCOMES:
CO1: Demonstrate finite element analysis techniques
CO2: Solve 2 dimensional finite element problems.
CO3: Analyze of field problems for shape function
CO4: Determine the computational solution techniques for non linear problems
CO5: Apply finite element analysis techniques to analyse the production processes

REFERENCES
CM4006 ADVANCES IN WELDING AND CASTING TECHNOLOGY

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COURSE OBJECTIVES:
- To impart knowledge on Metallurgy of welding.
- To be acquainted with Special welding processes.
- To elaborate gating system design and metallurgy.
- To provide knowledge on Special casting processes.
- To familiarize the students with automation and environmental aspects of welding and casting.

UNIT I WELDING DESIGN
9

UNIT II SPECIAL WELDING PROCESSES
9

UNIT III CASTING DESIGN
9
Introduction - Solidification shrinkage- - Pattern allowances- Design of gating System-Design of thin and unequal sections -Rapid solidification processing (RSP) - Melt spinning -Roll quenching - Vibratory solidification -Splat cooling - Thixoforming – Rheocasting - Single crystal growing Casting defects, inspection, diagnosis and rectification – Case study on casting design.

UNIT IV SPECIAL CASTING PROCESSES
9

UNIT V AUTOMATION AND ENVIRONMENTAL ASPECTS OF WELDING AND CASTING 9

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Use design knowledge to overcome defects in welding.
CO2: Select suitable welding process for the given applications.
CO3: Use design knowledge to produce quality casting.
CO4: Select suitable casting process for the given applications.
CO5: Implement automation principles with environment consciousness techniques in welding and casting plants

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REFERENCES:

CM4007 PRECISION ENGINEERING

COURSE OBJECTIVES:
- To gain knowledge of the need for precision engineering and its application.
- To familiarize the importance of materials in precision engineering.
- To introduce latest topics in manufacturing like micro machining and MEMS in order to equip them to join core facturing industries.
- To impart knowledge about the causes of errors and their remedies.
- To introduce the students with elements used in precision machines.

UNIT I INTRODUCTION

UNIT II MATERIALS FOR PRECISION ENGINEERING

UNIT III PRECISION MACHINING
UNIT IV  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 V  PRECISION MACHINE ELEMENTS


COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Understand the need of precision engineering and its application.
CO2: Discuss process knowledge to use the light material / superior material as per the raising demands.
CO3: Discuss the advanced precision machining processes.
CO4: Explain the various errors, its causes and remedies to overcome these.
CO5: Describe elements used in precision machine tool.

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MF4091  MANUFACTURING MANAGEMENT

OBJECTIVES
1. Students will be able to study the concepts in facility planning.
2. Students will be able to study types of plant layout and capacity planning methods.
3. Students will be able to study the concepts of Project management.
4. Students will be able to study the concepts and methods in production planning and control.
5. Students will be able to study the concepts in Inventory and maintenance management.
UNIT-I FACILITY PLANNING
Facility planning – Factors affecting selection of plant location, Factor rating analysis: Break – even analysis, Load distance model, closeness ratings – case study

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

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

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

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

COURSE OUTCOMES:
On Completion of the course the student will be able to
1. Able to acquire knowledge on facility, and problems associated with it.
2. Ability to learn the various capacity and layout planning models
3. Understand the concepts of demand forecasting and project management with relevant case studies.
4. Able to understand the concepts of production planning and scheduling.
5. Understand the various inventory and maintenance management techniques.

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REFERENCES:
COURSE OBJECTIVES:

- To provide knowledge in the areas of elastic and plastic behavior of materials.
- To understand the fracture behavior of materials.
- To elaborate the theories on plastic forming.
- To classify the different types of advanced materials.
- To select the material for specific industrial applications.

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, fibre and dispersion strengthening, work hardening - Effect of temperature, strain and strain rate on plastic behavior.

UNIT II  FRACTURE BEHAVIOUR

Types of fracture -Griffith’s theory, dislocation theory, ductile to brittle transition in steel – Stress intensity factor, fracture toughness and toughening mechanisms -High temperature fracture, creep - Larson-Miller Parameter - Deformation and fracture mechanism maps - Fatigue. Low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law, Effect of surface and metallurgical parameters on fatigue failure.

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


UNIT V  SELECTION OF MATERIALS AND TESTING

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 – Forgeability and castability test- NDT techniques.

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Discuss elastic plastic behavior of metals and its strengthening mechanisms.
CO2: Analyse the fracture behavior of metals and give solutions to avoid them.
CO3: Create processing techniques for controlling shape of the final product.
CO4: Select suitable materials for the specific industrial applications.
CO5: Able to work in R&D activity in the field of material science.

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CM4009 MICRO AND NANO MANUFACTURING

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

UNIT I INTRODUCTION
Introduction to Meso, Micro and Nano manufacturing, Miniaturization and applications, classification-subtractive, additive, micro casting, micro forming, micro joining.
Micro and Nano products

UNIT II MANUFACTURING METHODS
Material deposition – PVD, CVD, LIGA, Micro stereo lithography, Electro discharge deposition, Traditional micromachining- Theory of micromachining-Chip formation-size effect in micromachining, micro turning, micro drilling, micro milling, micro grinding, Diamond turn machining

UNIT III ADVANCED MACHINING / FINISHING PROCESSES

UNIT IV SYNTHESIS OF NANOMATERIALS

UNIT V CHARACTERISATION TECHNIQUES

TOTAL: 45 Periods
OUTCOMES:
CO1: Explain micro and nano manufacturing methods.
CO2: Extend material deposition methods for manufacturing
CO3: Select advanced machining process
CO4: Build nano composite materials
CO5: Analyze the nano materials and characterization techniques

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IL4093
SUPPLY CHAIN MANAGEMENT

OBJECTIVES:
- Explain the role of supply chain management in an organization.
- Identify the various aspects of supply chain management and the factors affecting them.
- Explain the relationship among various factors involved in planning, organizing and controlling supply chain operations.
- Summarize the sourcing and inventory decisions involved in supply chain operations.
- Explain the use of information technology in supply chain management.

UNIT I
INTRODUCTION SUPPLY CHAIN MANAGEMENT
Introduction, Types of supply chains with and examples, Evolution of SCM concepts, Supply chain performance, Strategic Fit, Drivers of Supply Chain Performance – key decision areas – External Drivers of Change. Supply contracts – centralized vs. decentralized system

UNIT II
SUPPLY CHAIN NETWORK DESIGN
Need for distribution network design- Factors affecting, Design options for distribution network. Network design decisions - Framework, factors influencing, Models of facility location and capacity allocation. Role of Transportation in supply chain, modes of transportation Modal Selection, Classification of carriers, Carrier Selection, Transportation Execution and Control. Food Mile Concept., design options.

UNIT III
DEMAND AND SUPPLY IN SUPPLY CHAIN
Distribution strategies-direct shipment, traditional warehousing, cross docking, inventory pooling, transhipment, Choosing appropriate strategy, Milk Run Model.

**UNIT IV SOURCING AND INVENTORY DECISIONS IN SUPPLY CHAIN**

Purchasing Vs Procurement Vs Strategic Sourcing, Item procurement importance matrix, Strategic Sourcing Methodology, Managing sourcing and procurement process, Supplier selection and evaluation, Bullwhip effect and its management, Economies of scale in supply chain- Cycle inventory, Estimation, Quantity discounts, Multiechelon cycle inventory. Uncertainty in supply chain- Safety inventory, Determination of appropriate level, Impact on uncertainty.

**UNIT V SUPPLY CHAIN AND INFORMATION SYSTEMS**


**TOTAL: 45 PERIODS**

**OUTCOMES:**

Students will be able to:

CO1: To introduce the concepts and elements of supply chain management.

CO2: to understand supply chain network design aspects for various manufacturing and service sectors.

CO3: To understand the principle of demand and supply in supply chain

CO4: To gain knowledge on the sourcing and inventory decisions in supply chain.

CO5: To understand the concepts of supply chain information systems.

**REFERENCES**


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**IL4075 LEAN MANUFACTURING AND SIX SIGMA**

**OBJECTIVES:**

- Summarize the basics of Lean and Six Sigma.
- Describe the need and the process of integrating Lean and Six sigma.
- Identify and select the resources required for LSS Projects and selection of projects including Team building.
- Infer the DMAIC process and study the various tools for undertaking LSS projects.
- Relate how to institutionalize the LSS efforts.
UNIT I INTRODUCTION TO LEAN AND SIX SIGMA
Introduction to Lean- Definition, Purpose, Features of Lean ; Top seven wastes, Need for Lean management, The philosophy of lean management, Creating a lean enterprise, Elements of Lean, Lean principles, the lean metric, Hidden time traps. Introduction to quality, Definition of six sigma, origin of six sigma, Six sigma concept and Critical success factors for six sigma; Case analysis.

UNIT II INTEGRATION OF LEAN AND SIX SIGMA
Evolution of lean six sigma, the synergy of Lean and six sigma, Definition of lean six sigma, the principles of lean six sigma, Scope for lean six sigma, Features of lean six sigma. The laws of lean six sigma, Key elements of LSS, the LSS model and the benefits of lean six sigma. Initiation - Top management commitment – Infrastructure and deployment planning, Process focus, organizational structures, Measures – Rewards and recognition, Infrastructure tools, structure of transforming event and Launch preparation; Case study presentations.

UNIT III PROJECT SELECTION AND TEAM BUILDING
Resource and project selection, Selection of Champions, Identification of potential projects, top down (Balanced score card) and Bottom up approach – Methods of selecting projects – Benefit/Effort graph, Process mapping, value stream mapping, Predicting and improving team performance, Nine team roles and Team leadership; Case study presentations .Black belts, Training of Black belts

UNIT IV THE DMAIC PROCESS AND TOOLS
The DMAIC process – Toll gate reviews; The DMAIC tools; Define tools – Project definition form, SIPOC diagram; Measure tools – Process mapping, Lead time/cycle time, Pareto chart, Cause and Effect matrix, FMEA; Idea – generating and organizing tools – Brainstorming, Nominal group technique, Multi-voting and Cause and effect diagram, Data collection and accuracy tools- Check sheet, Gauge R&R; Understanding and eliminating variation- run charts, control charts and process capability analysis; Analyze tools - Scatter plots, ANOVA, Regression analysis, Time trap analysis; Improve tools – Mistake proofing, Kaizen, set up time reduction (SMED), TPM, DOE and the pull system. Control tools – statistical process control.

UNIT V INSTITUTIONALIZING AND DESIGN FOR LSS
Institutionalizing lean six sigma – improving design velocity, creating cycle time base line, valuing projects, gating the projects, reducing product line complexity, Design for lean six sigma, QFD, Theory of Inventive Problem solving (TRIZ), Robust design; Case study presentations.

OUTCOMES:
CO1: The students will be able to understand what is Lean and Six sigma and their importance in the globalised competitive world.
CO2: The students will be able to understand the importance of integrating Lean and Six sigma and also the process of their integration.
CO3: The students will be able to plan the Resources required to undertake the LSS projects and also acquire how to select the suitable projects and the teams.
CO4: The students will be able apply DMAIC methodology to execute LSS projects and in this regard they will be acquainted with various LSS tools.
CO5: The students will be able to understand the process of institutionalizing the LSS effort and also understand the Design for LSS.

REFERENCES:
IL4071  ADVANCED OPTIMIZATION TECHNIQUES  

OBJECTIVES:
- Learn to solve integer programming problems
- To know how to solve the Dynamic programming problems
- Learn to solve non-linear programming problems with un constrained optimization problems
- Understand to solve non-linear programming problems using KKT conditions, quadratic and separable programming
- To create awareness of Meta heuristic algorithms.

UNIT I  INTEGER PROGRAMMING  
Branch and Bound technique –cutting plane algorithm method - Travelling Salesman problem - Traveling Salesman Problem - Branch and Bound Algorithms for TSP - Heuristics for TSP - Chinese Postman Problem - Vehicle Routeing Problem

UNIT II  DYNAMIC PROGRAMMING  

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

UNIT IV  NONLINEAR PROGRAMMING – II  

UNIT V  NON-TRADITIONAL OPTIMIZATION  

OUTCOMES:
CO1: Know how to solve integer programming problems
CO2: Able to solve Dynamic programming problems
CO3: Familiar in solving unconstrained non linear optimization problems
CO4: Familiar in solving constrained linear optimization problems
CO5: Know how to solve non linear optimization problems using Meta heuristic algorithms

TOTAL: 45 PERIODS
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CM4010 MACHINE LEARNING L TP C

COURSE OBJECTIVES:
This course will make students
1. To learn the basic aspects of machine learning.
2. To get basic knowledge on supervised learning.
3. To realize the importance of unsupervised learning.
4. To exposed on direct and indirect neuro control schemes.
5. To get insight into the basic knowledge on fuzzy logic systems

UNIT-I INTRODUCTION TO MACHINE LEARNING

UNIT-II SUPERVISED LEARNING

UNIT-III UNSUPERVISED LEARNING
Introduction – Clustering:-Partitioning Methods:- K-means algorithm - Hierarchical clustering –Fuzzy Clustering – Clustering High-Dimensional Data: - Problems – Challenges – Subspace Clustering – Biclustering- Self Organizing Map (SOM) - SOM algorithm

UNIT-IV NEURAL NETWORKS FOR MODELING AND CONTROL
Need for using ANN in Modeling and Control – Modeling of non-linear systems using ANN:Generation of training data, Identification of Optimal architecture, Model validation – Control of nonlinear systems using ANN: Direct and Indirect neuro control schemes – Adaptive neuro controller
UNIT-V  FUZZY LOGIC SYSTEMS  9

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, students will be able
CO1: To get familiarize with the basic aspects of machine learning.
CO2: To get exposure on supervised and unsupervised learning.
CO3: To demonstrate the need for neutral networks for modelling and control
CO4: To get familiarize with the fuzzy logic systems.
CO5: To realize the importance of machine learning and its applications.

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REFERENCES:

CM4072  ELECTRONICS MANUFACTURING TECHNOLOGY  L  T  P  C
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OBJECTIVES:
- To impart knowledge on wafer preparation and PCB fabrication
- To introduce Through Hole Technology (THT) and Surface Mount Technology (SMT) with various types of electronic components
- To elaborate various steps in Surface Mount Technology (SMT)
- To be acquainted with various testing and inspection methods of populated PCBS
- To outline repair, rework and quality aspects of Electronic assemblies.

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  8
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  SOLDERING AND CLEANING  9
Soldering theory, effect of elemental constituents on wetting, microstructure and soldering, solder paste technology – fluxing reactions, flux chemistry, solder powder, solder paste composition and

UNIT IV 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, underfill and encapsulation process, applications, storage and handling, process & parameters.

UNIT V INSPECTION, TEST AND REWORK FOR PCB: 9

OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Realize wafer preparation and PCB fabrication.
CO2: Elaborate on through hole and surface mount technology components.
CO3: Discuss the steps involved in soldering post solder cleaning and its importance in PCB manufacturing.
CO4: Improve knowledge on surface mount technology.
CO5: Locate the required inspections, testing and repair methods used in PCB.

REFERENCES
CM4011  ENVIRONMENT CONSCIOUS MANUFACTURING  L  T  P  C
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OBJECTIVES:
- To impart knowledge on sustainable manufacturing concepts and standards
- To gain an insight on green manufacturing initiatives
- To get familiarized with environment conscious design
- To explore methods that support environmental friendly manufacturing
- To understand the Life Cycle Assessment process

UNIT I  SUSTAINABLE MANUFACTURING AND EMS:  9

UNIT II  GREEN MANUFACTURING:  9
Green Design and Quality Initiatives - Environmental Cost Accounting and Business Strategy - Accounting for an Environmentally Conscious Setting - The Development of Eco labelling Schemes

UNIT III  RECYCLING:  9
Recycling as Universal Resource Policy - Innovation Towards Environmental Sustainability In Industry - A Systematic Framework for Environmentally Conscious Design

UNIT IV  ENVIRONMENTAL ATTRIBUTES OF MANUFACTURING:  10
Environmental Attributes of Manufacturing Processes - Environmental Decision Support Systems - Decision Models for Reverse Production System Design - Environmentally Sound Supply Chain Management

UNIT V  LIFE CYCLE ASSESSMENT  8
Life Cycle Assessment - Multipath way and Cumulative Risk Assessment - Reclamation And Recycling of Waste

TOTAL: 45 PERIODS

OUTCOMES:
At the end of this course, the students shall be able to
CO1: Take advantage of sustainable manufacturing concepts and standards
CO2: Deploy green manufacturing initiatives
CO3: Apply the environment conscious design
CO4: Take advantage of environmental friendly manufacturing methods
CO5: Apply the Life Cycle Assessment process

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OBJECTIVES:
- To impart the knowledge in optimization,
- To explore multi objective optimization,
- To learn evolutionary algorithms,
- To understand Evolutionary strategies and programming.
- To get familiarized in Multi-Objective Evolutionary algorithm

UNIT I INTRODUCTION TO OPTIMIZATION: 9
Introduction to optimization - single and multi objective optimization - Evolutionary algorithms - principles of multi objective optimization.

UNIT II MULTI OBJECTIVE OPTIMIZATION: 9
Convex programming, Karush-Kuhn-Tucker conditions, Direct functional evaluation and derivative based optimization techniques;

UNIT III EVOLUTIONARY ALGORITHMS: 9
Simulated annealing, Tabu search; NFL theorem; Biological principles of evolution, General scheme of EAs, Representation, Selection schemes, Population evaluation, Variation operators; Constraint handling; Schema theorem; Binary coded genetic algorithm, Real coded genetic algorithm.

UNIT IV EVOLUTIONARY STRATEGIES AND EVOLUTIONARY PROGRAMMING 9
Evolutionary strategies, Evolutionary programming, genetic programming, Differential evolution, Particle swarm optimization;

UNIT V APPLICATIONS OF MULTI-OBJECTIVE EVOLUTIONARY ALGORITHMS: 9
Pareto-optimality, Multi-objective evolutionary algorithms; Statistical analysis of EC techniques; Customization in EAs; Applications of multi-objective evolutionary algorithms - Mechanical component design - Truss-structure design - Other applications.

OUTCOME:
CO1: Demonstrate principles of optimization process
CO2: Make use of multi response optimization
CO3: Inference to the evolutionary programming
CO4: Evaluate the process parameters for optimization
CO5: Apply optimization techniques in mechanical component design

REFERENCES
OBJECTIVES:
- To understand the basic principles of intelligent product design and manufacturing.
- To study the various techniques of knowledge representation.
- To study the different modelling techniques in intelligent product design and manufacturing.
- To apply the neural networks in manufacturing systems.
- To understand and develop the web based CAD/CAM internet model.

UNIT I  INTRODUCTION TO INTELLIGENT DESIGN AND MANUFACTURING:  9
Need - Internet technology and Manufacturing Industry - Digital enterprises - Manufacturing portals – Benefits.

UNIT II  TECHNIQUES OF KNOWLEDGE REPRESENTATION  9

UNIT III  INTELLIGENT PRODUCT MODELING TECHNIQUES:  9
Intelligent CAD systems, integrating product and process design, manufacturing analysis and CAD/CAM integration, design methodology for automated manufacture, the impacts of intelligent process control on product design, and fuzzy knowledge-based controller design.

UNIT IV  APPLICATION OF NEURAL NETWORKS:  9
Neural Networks for Intelligent Process Monitoring and Control : Applications to CNC machining, Metal Forming - Intelligent Manufacturing Planning, Scheduling and Control - Intelligent Assembly and Layout Planning.

UNIT V  INTERNET BASED COLLABORATIVE CAD/CAM :  9
Applications to web based CAD, CAPP, CNC, Assembly planning, and Rapid Prototyping - Challenging issues of Collaborative CAD/CAM.

OUTCOMES:
CO1: Demonstrate Internet technology in manufacturing Industry
CO2: Make use of techniques of Knowledge Representation
CO3: Analysis of various CAD/CAM system
CO4: Apply neural networks for intelligent process monitoring and control
CO5: Develop web based CAD/CAM internet model

REFERENCES
COURSE OBJECTIVES:
To know the concepts of Artificial Intelligence
To Practice the methods of solving problems using Artificial Intelligence
To build components of intelligent decision support system for Manufacturing
To understand intelligent systems and its troubleshooting methods
To investigate and deploy Artificial Intelligence for future smart manufacturing factories.

UNIT I  INTRODUCTION

UNIT II  ARTIFICIAL INTELLIGENCE LANGUAGES
Heuristic search-logic programming and reasoning-automatic programming-scope of AI-in manufacturing components of intelligent manufacturing Aspects of intelligence and AI Requirements of AI languages, LISP & PROLOG – Simple programs

UNIT III  BUILDING OF KNOWLEDGE BASED SYSTEMS
Knowledge engineering-protocol analysis -fuzzy logic -Semantic networks, Learning systems Knowledge Engineering Knowledge representation – Knowledge acquisition and optimization -Knowledge based approaches to design mechanical parts and mechanisms and design for automated assembly.

UNIT IV  INTELLIGENT SYSTEMS
Knowledge based system for material selection – Intelligent process planning system. Intelligent system for equipment selection -Intelligent system for project management & factory monitoring. Inference engine Vision programmes-factory vision systems -machine learning

UNIT V  FACTORIES OF FUTURE
The role of Artificial Intelligence in the factory of the future Features of Experts systems -applications in manufacturing planning and control – Intelligent systems. Scheduling in manufacturing – scheduling the shop floor – Diagnosis & trouble shooting.

TOTAL 45 PERIODS

COURSE OUTCOMES:
CO1: Apply various knowledge based techniques
CO2: Build components of intelligent decision support system
CO3: Adopt intelligent system for Manufacturing
CO4: Demonstrate the concepts of Artificial Intelligence
CO5: Solve problems using Artificial Intelligence

REFERENCES
OBJECTIVES:
- To introduce MEMS, Microsystems, materials and working of MEMS and Microsystems
- To explain the scaling laws in miniaturization and design for microsystems
- To familiarize with different microsystem fabrication processes.
- To learn packaging, interfaces and assembly of microsystems
- To gain knowledge in different measurement and characterization methods for MEMS

UNIT I INTRODUCTION

UNIT II MECHANICS, SCALING AND DESIGN

UNIT III MICRO SYSTEM FABRICATION PROCESSES
Introduction- Photolithography- Ion implantation- Chemical Vapor Deposition-Physical Vapor Deposition -clean room- Bulk micromachining :etching, isotropic and anisotropic etching, wet and dry etching-Surface micro machining :process, mechanical problems associated with surface micro machining- LIGA process :general description, materials for substrates and photo resists-SLIGA process-Abrasive jet micro machining-Laser beam micro machining- Micro Electrical Discharge Micro Machining –Ultrasonic Micro Machining- Electro chemical spark micro machining- Electron beam micro machining-Focused Ion Beam machining

UNIT IV MICROSYSTEMS PACKAGING
Introduction - Microsystems Packaging-Interfaces in Microsystems Packaging-Essential Packaging Technologies- Die preparation, surface bonding, wire bonding, sealing- Three dimensional Packaging-Assembly of Microsystems, Signal Mapping and Transduction

UNIT V MICROMETROLOGY AND CHARACTERIZATION

OUTCOME:
CO1: Explain the concept of Micro Electro Mechanical systems
CO2: Develop micro system design
CO3: Identify the elements of MEMS system
CO4: Determine the scaling and design methods
CO5: Examine the micro metrology and characterization

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PD4391 PRODUCT LIFECYCLE MANAGEMENT

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OBJECTIVES:
1. To understand history, concepts and terminology of PLM
2. To understand functions and features of PLM/PDM
3. To understand different modules offered in commercial PLM/PDM tools
4. To demonstrate PLM/PDM approaches for industrial applications
5. To Use PLM/PDM with legacy data bases, CAx & ERP systems

UNIT I HISTORY, CONCEPTS AND TERMINOLOGY OF PLM
Introduction to PLM, Need for PLM, opportunities of PLM, Different views of PLM - Engineering Data Management (EDM), Product Data Management (PDM), Collaborative Product Definition Management (cPDm), Collaborative Product Commerce (CPC), Product Lifecycle Management (PLM). PLM/PDM Infrastructure – Network and Communications, Data Management, Heterogeneous data sources and applications.

UNIT II PLM/PDM FUNCTIONS AND FEATURES

UNIT III DETAILS OF MODULES IN APDM/PLM SOFTWARE
Case studies based on top few commercial PLM/PDM tools

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

UNIT V BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE
PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD, SLM and ERP

OUTCOMES:
The students will be able to
1. Summarize the history, concepts and terminology of PLM
2. Use the functions and features of PLM/PDM
3. Use different modules offered in commercial PLM/PDM tools.
4. Implement PLM/PDM approaches for industrial applications.
5. Integrate PLM/PDM with legacy data bases, CAx & ERP systems.
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CM4071 MANUFACTURING SYSTEM SIMULATION

OBJECTIVES:
- To discuss the importance and advantages of applying simulation and modelling techniques
- To teach various random number generation techniques, its use in simulation
- To explain the applications of random probability distributions in real time environments.
- To train students to solve discrete event problems using software.
- To train students on Simulation models using a simulation software.

UNIT I INTRODUCTION
- Systems and its types, Types of Modelling, Principles used in Modeling, simulation as a decision making tool, types of simulation, Advantages and disadvantages of simulation, Steps in simulation model building - statistical models in simulation -discrete and continuous system

UNIT II RANDOM NUMBERS

UNIT III RANDOM VARIATES

UNIT IV ANALYSIS OF SIMULATION DATA
- Input modelling-Fitness tests – verification and validation of simulation models – output analysis for a single model, Comparison and evaluation of alternate system design, Optimization using simulation.
UNIT V SIMULATION LANGUAGES AND CASE STUDIES
Simulation languages and packages-Case studies in WITNESS; FLEXSIM, ARENA, SIMQUICK-
Simulation based optimization-Modelling and Simulation with Petrinets -Case studies in manufacturing and material handling system- Monte Carlo Simulation. Simulation of Single Server Queuing System. Simulation of manufacturing shop Simulation of Inventory System

TOTAL: 45 PERIODS

OUTCOMES
CO1: Explain the Manufacturing Models of Discrete event systems
CO2: Develop the Uncertainty using Random numbers and Random Variates
CO3: Analyze the verification & valediction of Models and Optimization
CO4: Demonstrate the concepts of modeling layers of society's critical infrastructure networks
CO5: Make use of tools to view and control simulations

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CM4016 MANUFACTURING INFORMATION SYSTEMS

OBJECTIVES:
- To introduce the evolution of order policies and agile manufacturing information systems
- To elaborate database terminologies, data models, data independence and trends in database
- To impart knowledge on database designing, normalization types and query languages
- To give an overview of modules involved in inventory, process flow and shop floor control
- To be acquainted with integration of the modules to function as a single application that aids different departments of factory

UNIT I INTRODUCTION:
The Evolution of order policies, from MRP to MRP II to ERP – Agile Manufacturing Information Systems, Manufacturing Database Integration.

UNIT II DATABASE:

UNIT III DESIGNING DATABASE:
Hierarchical model – Network approach- Relational Database concepts, principles, keys,- functional dependency – Normalization types – relational operations- Query Languages-Case studies.

UNIT IV MANUFACTURING CONSIDERATION:
The product and its structure, inventory and process flow – Shop floor control Data structure and procedure – various models – the order scheduling module, Input/output analysis module, and stock status database – the complete IOM database.
UNIT V INFORMATION SYSTEM FOR MANUFACTURING:

Parts oriented production information system – concepts and structure – Computerized production scheduling, online production control systems, Computer based production management system, computerized manufacturing information system -RFID-Telecommunication– case study.

TOTAL: 45 PERIODS

OUTCOMES

At the end of this course, the students shall be able to
CO1: Perceive the evolution of order policies, agile manufacturing information systems and manufacturing database integration
CO2: Explain the database terminologies, data models, data independence and trends in database
CO3: Acquire knowledge on database designing, normalization types and query languages
CO4: Elaborate modules involved in inventory, process flow and shop floor control
CO5: Understand the integration of the modules to function as a single application that aids different departments of factory

REFERENCES

8. www.ist.psu.edu

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CM4017 SUSTAINABLE MANUFACTURING

COURSE OBJECTIVES

- To be acquainted with sustainability in manufacturing and its evaluation.
- To provide knowledge in environment and social sustainability.
- To provide the student with the knowledge of strategy to achieve sustainability.
- To familiarize with trends in sustainable operations.
- To create awareness in current sustainable practices in manufacturing industry.

UNIT I ECONOMIC 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 - need to reduce the carbon footprint of manufacturing Operations - 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 -Modeling 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

UNIT IV MANUFACTURING STRATEGY FOR SUSTAINABILITY

Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs

UNIT V TRENDS IN SUSTAINABLE OPERATIONS

Principles of sustainable operations - Life cycle assessment manufacturing and service activities - Influence of product design on operations - Process analysis - Capacity management – Quality management -Inventory management - Just-In-Time systems - Resource efficient design - Consumerism and sustainable well-being

COURSE OUTCOMES:

At the end of this course, the students shall be able to:
CO1: Discuss the importance of economic sustainability.
CO2: Describe the importance of sustainable practices.
CO3: Identify drivers and barriers for the given conditions.
CO4: Formulate strategy in sustainable manufacturing.
CO5: Plan for sustainable operation of industry with environmental, cost consciousness

TOTAL: 45 PERIODS

REFERENCES:

OBJECTIVES:

- Describe an idea about ERP
- Creating awareness of core and extended modules of ERP
- Extract knowledge of ERP implementation cycle
- Gaining knowledge about effects of ERP after its implementation.
- Understanding the emerging trends on ERP

UNIT I  INTRODUCTION  9
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  9
Overview of ERP software solutions- Small, medium and large enterprise vendor solutions, BPR, and best business practices - Business process Management, Functional modules.

UNIT III  ERP IMPLEMENTATION  9

UNIT IV  POST IMPLEMENTATION  9
Maintenance of ERP- Organizational and Industrial impact; Success and Failure factors of ERP Implementation.

UNIT V  EMERGING TRENDS ON ERP  9
Extended ERP systems and ERP add-ons -CRM, SCM, Business analytics - Future trends in ERP systems-web enabled, Wireless technologies, cloud computing

TOTAL: 45 PERIODS

OUTCOMES
CO1: Get an idea about ERP
CO2: Awareness of core and extended modules of ERP
CO3: Knowledge of ERP implementation cycle
CO4: Gain knowledge about effects of ERP after its implementation.
CO5: Understand the emerging trends on ERP

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

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**CC4071 ADVANCED MACHINE TOOL DESIGN**

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### COURSE OBJECTIVES

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

1. Selecting the different machine tool mechanisms.
2. Designing the Multi speed Gear Box and feed drives.
3. Designing the machine tool structures.
4. Designing the guideways and power screws.
5. Designing the spindles and bearings.

### UNIT I INTRODUCTION TO MACHINE TOOL DESIGN

**Introduction**

- Machine Tool Drives and Mechanisms
- Auxiliary Motions in Machine Tools
- Kinematics of Machine Tools
- Motion Transmission

### UNIT II REGULATION OF SPEEDS AND FEEDS

**Aim**

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

### UNIT III DESIGN OF MACHINE TOOL STRUCTURES

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

### UNIT IV DESIGN OF GUIDEWAYS AND POWER SCREWS

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

### UNIT V DESIGN OF SPINDLES AND SPINDLE SUPPORT

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

**TOTAL = 45 PERIODS**

### OUTCOMES:
On Completion of the course the student will be able to:

1. Select the different machine tool mechanisms.
2. Design the Multi speed Gear Box and feed drives.
3. Design the machine tool structures.
4. Design the guideways and power screws.
5. Design the spindles and bearings.

### REFERENCES:

OBJECTIVES:
- To teach the different aspects of manufacturing and competitiveness
- To identify the flow design for products
- To make the students select job design and work measurement
- To train the students to evaluate MRP systems and inventory model
- To create ability to apply reengineering concepts in manufacturing

UNIT I: INTRODUCTION:
6
Elements – Manufacturing Strategies and competitiveness – Meeting the competitive Project management.

UNIT II: DESIGNING OF PRODUCTS:
9

UNIT III: DESIGN OF FACILITIES AND JOBS:
10

UNIT IV: INVENTORY SYSTEMS AND MRP:
10
Definition – Purposes of Inventory – Inventory models – Fixed order Quantity models and Fixed-time period models. MRP Systems – MRP system structures – Improvements for MRP system – Advanced MRP-type systems.

UNIT V: REVISITING THE SYSTEM:
10

TOTAL: 45 PERIODS

OUTCOME:
CO1: Able to classify the different aspects of manufacturing
CO2: Able to identify the flow design for products
CO3: Ability to evaluate MRP systems and inventory model
CO4: Capacity to select job design and work measurement
CO5: Know the procedure to apply reengineering concepts in manufacturing
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IL4092 PROJECT MANAGEMENT

OBJECTIVES:
Compare various models used in project selection.
Define project planning, and estimate the cost involved.
Apply network techniques for project scheduling and resource allocation.
Summarize the information needed planning, monitoring and controlling cycle of a project.
Recognize the values of project audit.

UNIT I STRATEGIC MANAGEMENT AND PROJECT SELECTION 9
Project selection models, Project portfolio process, Analysis under uncertainty, Project organization, Matrix organization

UNIT II PROJECT PLANNING AND COST ESTIMATION 9

UNIT III PROJECT IMPLEMENTATION 9
Scheduling: Network Techniques PERT and CPM, Risk analysis using simulation, CPM- crashing a project, Resource loading, leveling, and allocation.

UNIT IV MONITORING AND INFORMATION SYSTEMS 9
Information needs and the reporting process, computerized PMIS, Earned value analysis, Planning-Monitoring-Controlling cycle, Project control: types of control processes, design of control systems, control of change and scope

UNIT V PROJECT AUDITING 9
Construction and use of audit report, Project audit life cycle, Essentials of audit and evaluation, Varieties of project termination, the termination process, The Final Report – A project history

OUTCOMES:
CO1 - Understand various models used in project selection.
CO2 - Acquire knowledge in project planning, and estimate the cost involved.
CO3 - Prepare Project Scheduling and resource allocation.
CO4 - Understand about planning, monitoring and controlling cycle of a project.
CO5 - Understand the values of project audit.

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

CM4020 RELIABILITY AND TOTAL PRODUCTIVE MAINTENANCE

OBJECTIVE:
• To gain an insight on Reliability function and life time calculations relevant to maintenance
• To get familiarized with various failure data analysis methods
• To be acquainted with various reliability prediction methods
• To get accustomed with reliability estimation techniques
• To understand the concepts of Total Productive Maintenance

UNIT I INTRODUCTION
Reliability function - MTBF - MTTF - mortality curve - availability - Maintainability.

UNIT II FAILURE DATA ANALYSIS:
Repair time distributions - exponential, normal, log normal, gamma, and Weibull - reliability data requirements - Graphical evaluation.

UNIT III RELIABILITY PREDICTION:

UNIT IV RELIABILITY MANAGEMENT:
Reliability demonstration testing - Reliability growth testing - Duane curve - Risk assessment - FMEA, Fault tree.

UNIT V TOTAL PRODUCTIVE MAINTENANCE:

TOTAL: 45 PERIODS
OUTCOMES:
At the end of this course, the students shall be able to
CO1: Use the Reliability function and life time calculations relevant to maintenance
CO2: Apply the failure data analysis methods
CO3: Deploy various reliability prediction methods
CO4: Apply the reliability estimation techniques
CO5: Take advantage of Total Productive Maintenance concepts

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CM4021 SENSORS FOR MANUFACTURING AND CONDITION MONITORING L T P C
3 0 0 3

OBJECTIVES:
- To make students familiar with various sensors in manufacturing and signal processing.
- To impart knowledge on sensors used in workpiece monitoring.
- To explain various sensors used in machine tool monitoring.
- To learn various sensors used in machining process monitoring.
- To brief the advanced and smart sensor technologies.

UNIT I INTRODUCTION TO SENSORS
Role of sensors in manufacturing and condition monitoring – Principles – Classification Applications – Basic requirements of sensor – Signal processing and decision making.

UNIT II SENSORS FOR WORKPIECE MONITORING
Mechanical, Electrical, Electro-mechanical, Opto-electrical, Optical, Pneumatic, Capacitance, Eddycurrent and Magnetic sensors.

UNIT III SENSORS FOR MACHINE TOOL MONITORING
Position measurements: Linear, angular and velocity sensors – Calibration of machine tools – Collision detection measurements.
UNIT IV  SENSORS FOR MACHINING PROCESSES


UNIT V  ADVANCED SENSORS


TOTAL: 45 PERIODS

OUTCOME:
At the end of this course, the students shall be able to:
CO1: Recognize the importance of sensors and condition monitoring in manufacturing.
CO2: Identify suitable sensors for monitoring workpiece during machining operation.
CO3: Identify suitable sensors for monitoring machine tool during machining operation.
CO4: Identify suitable sensors in monitoring the machining process.
CO5: Perceive the usage and importance of advanced sensors in manufacturing industries.

REFERENCES
CM4091  GREEN MANUFACTURING  L  T  P  C
3  0  0  3

COURSE OBJECTIVES
1. To expose the students to the basics of environmental sustainability and impact assessment objectives.
2. To incorporate knowledge about the environmental based improvements towards lean manufacturing systems.
3. To analyze various machineries with intent to conserve energy.
4. To analyze hazardous and solid wastes with intent to point out areas of adverse environmental impact and how this impact could be minimized or prevented.
5. To impart the knowledge about the need, procedure and benefits of Green-Co rating.

UNIT – I  ENVIRONMENTAL SUSTAINABILITY AND IMPACT ASSESSMENT  9
Environmental impact assessment objectives – Legislative development – European community directive – Hungarian directive. Strategic environmental assessment and sustainability appraisal. Regional spatial planning and environmental policy.

UNIT – II  LEAN MANUFACTURING AND GREEN ENERGY SYSTEM  9

UNIT – III  ENERGY SAVING MACHINERY AND COMPONENTS  9

UNIT – IV  HAZARDOUS AND SOLID WASTE MANAGEMENT  9

UNIT – V  GREEN CO-RATING  9

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
CO1: Understand the Concepts of environmental sustainability and environmental impact assessment objectives
CO2: Apply suitable schemes towards design of green manufacturing requirements.
CO3: Analyze manufacturing processes towards conservation of energy.
CO4: Analyze manufacturing processes towards minimization or prevention of hazardous and solid wastes.
CO5: Acquire Knowledge of green co-rating and its benefits are well known to the students.
CO-PO MAPPING:

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REFERENCES:
4. World Commission on Environment and Development (WCED), Our Common Future, Oxford

CM4022 MATERIAL CHARACTERIZATION TECHNIQUES

OBJECTIVES:
- To impart knowledge in specimen preparation techniques, microstructure evaluation of materials.
- To elaborate X-ray diffraction techniques and crystal structure identification.
- To acquire knowledge in various microscopy techniques
- To get insights into different methods of chemical and thermal analysis
- To understand and practice various mechanical testing methods.

UNIT I MICROSTRUCTURAL EVALUATION:

UNIT II CRYSTAL STRUCTURE ANALYSIS:

UNIT III ELECTRON MICROSCOPY:

UNIT IV CHEMICAL AND THERMAL ANALYSIS:
Basic principles, practice and applications of X-ray spectrometry, Wave dispersive X-ray spectrometry, Auger spectroscopy, Secondary ion mass spectroscopy, Fourier Transform Infrared Spectroscopy (FTIR) – proton induced X-ray Emission spectroscopy, Differential thermal analysis, Differential Scanning Calorimetry (DSC) and Thermo Gravimetric Analysis (TGA)
UNIT V MECHANICAL TESTING:


OUTCOME:
CO1: Apply various material characterization techniques for research and analysis.
CO2: Evaluation of microstructure for materials
CO3: Explain the crystal structure analysis, electron microscopy
CO4: Analyze the Chemical, Thermal analysis
CO5: Make use of mechanical testing methods.

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CM4023 TOOL ENGINEERING

OBJECTIVES:
- To introduce the various materials and tools for production of components.
- To impart knowledge in design of various cutting tools and its nomenclature.
- To familiarize in designing dies for various processes.
- To understand the design of differenten jigs and fixtures
- To be acquainted with various gauges and tool design for CNC machines.

UNIT I INTRODUCTION:

Broad Classification of Tools-Cutting tools, Dies, Holding and Measuring tools, Tool materials and heat treatment- Ferrous, Non-ferrous and Non metallic materials, tool making practices.
UNIT II  DESIGN OF CUTTING TOOLS:  9
Single Point Cutting Tools: Classification, Nomenclature, geometry, design of single point tools for lathes, shapers, planers etc. Chip breakers and their design. Multipoint Cutting Tools: Classification and specification, nomenclature, Design of drills, milling cutters, broaches, taps etc. Design of Form Tools: Flat and circular form tools, their design and applications.

UNIT III  DESIGN OF DIES:  9

UNIT IV  DESIGN OF JIGS AND FIXTURES:  9
Classification of Jigs and Fixtures, Fundamental Principles of design of Jigs and Fixtures, Location and Clamping in Jigs and fixtures, Simple design for drilling Jigs, Milling fixtures etc. Indexing Jigs and fixtures.

UNIT V  DESIGN OF LIMIT GAUGES AND TOOL DESIGN FOR CNC MACHINES:  9
Fixed gauges, gauge tolerances, indicating gauges, automatic gauges, selection of materials, tool design for CNC machines- fixture design, cutting tools, tool holding, tool pre-setter, automatic tool changers and positioners.

TOTAL: 45 PERIODS

OUTCOMES:
CO1: Apply domain knowledge will increase their employability skills
CO2: Make use of this knowledge to develop innovative ideas work holding methods
CO3: Explain the encourages to involve in research in the area of machining
CO4: Improve the design of jigs and fixtures
CO5: Identify the measuring gauges

REFERENCES

CM4024  TOTAL QUALITY SYSTEMS AND ENGINEERING  L T P C
3 0 0 3

OBJECTIVE:
- To gain an insight on Totally quality systems
- To get familiarized with various quality audit systems
- To get acquainted with elements of TQM
- To appreciate implementation of quality by design concepts
- To get acquainted with the laws that governs the product quality and safety
UNIT I INTRODUCTION: 9
Definition of Quality and TQM - Importance of quality - Principles of Quality Management - Pioneers of TQM - Quality costs - Customer Orientation - Benchmarking - Re-engineering - Concurrent Engineering.

UNIT II PRACTICES OF TQM: 9

UNIT III TECHNIQUES OF TQM: 9

UNIT IV QUALITY BY DESIGN: 9

UNIT V PRODUCTS LIABILITY: 9

OUTCOMES:
At the end of this course, the students shall be able to
- CO1: Assess the Totally quality system concepts
- CO2: Recognize various quality audit systems
- CO3: Evaluate various elements of TQM
- CO4: Implement the quality by design concepts
- CO5: Recognize the laws that governs the product quality and safety

TOTAL: 45 PERIODS

REFERENCES
OBJECTIVES:
- To impart knowledge on various layout planning methods
- To get familiarized with various racking systems
- To gain an insight on material handling systems
- To learn various part feeding methods, optimum design of feeding routes and feeding methods
- To develop knowledge on warehouse management systems, safety requirements of warehouse panning

UNIT I LAYOUT PLANNING: 8
Layout Planning - Importance of Layout Planning - General Steps in Layout and Space Requirements Planning - Warehouse Activities - Determining Space Requirements – Develop realistic and Ideal Layout for Storage and Retrieval – Material storage methods for each part

UNIT II RACKING SYSTEMS FOR WAREHOUSE: 9

UNIT III MATERIAL HANDLING SYSTEMS FOR WAREHOUSE: 9
Material Handling System - Material Flow Path - Selection Criteria to Determine Equipment - Material Handling Equipment Classification – MHE Manufacturer's Worldwide Ranking - Comparison of Fork Lift, Reach Truck and Narrow Aisle Truck - MHE Service and Battery Charging - Crane Design Requirements

UNIT IV PART FEEDING: 10
Part feeding - Number of Tow Truck Requirements - Calculations - Kitting Trolley Route Map - Kitting Time Estimation - Kitting Trolley Feeding Man Power Calculation - Kitting Trolley Design Methodology - Assumptions in Kitting Design - Kit Trolley Design - Key Ware House Planning Issues to be Considered during Ware Housing Planning - Check List for Warehouse Layout Planning - Return on Assets

UNIT V WAREHOUSE MANAGEMENT SYSTEMS, SAFETY AND STAFFING 9
WMS Support in Ware House Management - Benefits of a WMS - Components of a WMS - WMS Data - WMS Functions - WMS Reports - Ware House Safety Requirements, Warehouse Staffing - Personnel Requirements for a Typical Warehouse.

OUTCOMES:
CO1: Apply the Design and plan warehouse layouts
CO2: Explain the Plan racking systems
CO3: Make use of material handling systems for warehouse requirements.
CO4: To take advantage of various part feeding mechanisms
CO5: Develop knowledge on warehouse management systems and identify the safety requirements of warehouse panning
REFERENCES
1. Bartholdi, J.J. and Hackman, S.T., "Warehouse & Distribution science", Release 0.89, The Supply chain and logistics Institute, School of Industrial and systems Engineering, Georgia Institute of technology, Atlanta, GA 30332-0205 USA, Revised August 20, 2008.
3. Hanson, R., "In-plant materials supply: Supporting the choice between kitting and continuous supply", Department of Technology Management and Economics, Chalmers University of Technology, Gothenburg, Sweden 2012. (http://publications.lib.chalmers.se/records/fulltext/155418.pdf)

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MR4071 INTERNET OF THINGS FOR MANUFACTURING  
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COURSE OBJECTIVES:
1. To understand the basics of IoT, Opportunities and challenges in IoT
2. To design a IoT solution
3. To develop an IoT prototype
4. To explain the various protocols used in IoT and Localization
5. To examine the applications of IoT in Manufacturing

UNIT I INTRODUCTION

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

UNIT III PROTOTYPING OF IoT

UNIT IV PREREQUISITES FOR IoT
IOT Technologies Wireless protocols low-power design (Bluetooth Low Energy), range extension techniques (data mining and mesh networking), and data-intensive IoT for continuous recognition applications Data storage and analysis Localization algorithms Localization for mobile systems
UNIT V APPLICATION IN MANUFACTURING

Applications HCI and IoT world - Multilingual interactions Robotics and Autonomous Vehicles Sensing and data processing-Simultaneous mapping and localization-Levels of autonomy, Smart factories, Future research challenges

TOTAL : 45 PERIODS

OUTCOMES:
On completion of the course, the students will be able to
CO1: Identify the Opportunities and challenges in IoT
CO2: Propose a suitable IoT design
CO3: Develop an optimized IoT prototype
CO4: Understand the various protocols used in IoT and Localization
CO5: Understand the applications of IoT in Manufacturing

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IS4071 DATA ANALYTICS L T P C
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COURSE OBJECTIVES:
1. Recognize the importance of data analytics
2. Exhibit competence on data analytics packages
3. Apply solution methodologies for industrial problems.

UNIT I INTRODUCTION

UNIT II MULTIPLE REGRESSION
Multiple Regression- Linear and Nonlinear techniques- Backward-Forward-Stepwise Hierarchical regression-Testing interactions (2way interaction) - Analysis of Variance and Covariance (ANOVA & ANCOVA) - Multivariate Analysis of Variance and Covariance (MANOVA & MANCOVA).
UNIT III LOGISTIC REGRESSION
Regression with binary dependent variable - Simple Discriminant Analysis Multiple Discriminant analysis-Assessing classification accuracy- Conjoint analysis (Full profile method).

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

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

COURSE OUTCOMES:
On completion of the course, the student will be able to:
• To recognize the importance of data analytics
• To Exhibit competence on data analytics packages
• To apply solution methodologies for industrial problems.

REFERENCES:

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

AX4091 ENGLISH FOR RESEARCH PAPER WRITING L T P C 2 0 0 0

COURSE OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

UNIT III TITLE WRITING SKILLS 6
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6
Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission

TOTAL: 30 PERIODS

COURSE OUTCOMES

CO1 – Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

REFERENCES

COURSE OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I  INTRODUCTION
Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II  REPERCUSSIONS OF DISASTERS AND HAZARDS
Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III  DISASTER PRONE AREAS IN INDIA
Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides and Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV  DISASTER PREPAREDNESS AND MANAGEMENT
Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V  RISK ASSESSMENT
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People’s Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

COURSE OUTCOMES
CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES
OBJECTIVES
Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional Role and entitlement to civil and economic rights as well as the emergence nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

UNIT I  HISTORY OF MAKING OF THE INDIAN CONSTITUTION
History, Drafting Committee, (Composition & Working)

UNIT II  PHILOSOPHY OF THE INDIAN CONSTITUTION
Preamble, Salient Features

UNIT III  CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

UNIT IV  ORGANS OF GOVERNANCE
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V  LOCAL ADMINISTRATION

UNIT VI  ELECTION COMMISSION
Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party (CSP) under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING
UNIT I

1. நற்றமிழ் துவக்க நூல் - சத்ருதியான, விளகுதி, புகுவிதம்
2. அகநொனூறு (82) - இயற்கைத் துவக்க நூல்
3. நற்றின் பார்வையும் பார்வைகள்
4. புறநொனூறு (95, 195) - பார்வை திருக்கொட்டம் முன்நோர்

UNIT II

1. அறநநறித் தமிழ் - அறநநறி வகுத்ததிருவள்ளுவர் - அர்த்தம் வலியுறுத்தல், அன்பு கடகம், பொருள் பர்
2. பிற அறநூல்கள் - இலக்கியம் மருந்து - முரயாதி, திரிகடுகம், திருக்கொட்டம், அரங்ககைதலை (குழவை மீது முன்நோர் காலம்)

UNIT III

1. திருக்காப்பியங்கள் - சேலம்சிப்பிக் பர்
2. மூககவிலகம் - திரிகடுகல் பொன்கலைகள் - தேர்தலரலம் அறக்பகொட்டமொகிய காலம்

UNIT IV

1. அருள்நநறித் தமிழ் - சிறுபொணொற்று - பொரி முல்கல்த் தகொடுத்தது, பபகன் மயிலுக்குப் பபொர்கவது, அலைககவைப் பொன்கலைகள், அருள் பண்புப்பில
2. தங்கிகை - இயற்கைக்கறி புன்கல்த் திரிப
3. சிற்பமிகரிய (617, 618) - தேவம் திரிபம் திரிகை
4. குறுன்றகாவரம் திரிபம் மாண்டராக
5. பர்மதேநர் - சிறுபொணொற்று பார்வை நூல்
6. அகநொனூறு (4) - பார்வை தமிழைமொனூறு (11) - பார்வை
   குறுன்றகாவரம் (11) - பார்வை, புரப்
   நூல்கள் 50 (27) - பார்வை
   ஆகிய பரிசயங்கள் விளக்கம்
UNIT V நாவீனதமிழிலக்கியம்

1. கல்குகர் தைமு, - கும்பிதின் முதல் புத்தகம், - கல்குகர் முதல் விளக்கம், - கல்குத்தார் தொக்கியல், - பயண தொக்கியல், - நொடகம்,
2. முதொயவிடுதகலயும் தமிழ் இலக்கியமும், - முதொயவிடுதகலயும் தமிழ் இலக்கியமும், - முதொயவிடுதகலயும் விளிம்பு நிக்கலயினரின் பம்பொட்டியில் தமிழ் இலக்கியமும்,
3. அரிசியம் தைமு, - தொட்டம்பாக்கிய தைமு, - இனத்தொட்டம்பாக்கிய தைமு, - தொட்டம்பாக்கிய தைமு.

TOTAL: 30 PERIODS

தமிழ் இலக்கியம் வருவியத்தி / புத்தகங்கள்

1. தமிழ் இக்கணயகல்விக்கழகம் (Tamil Virtual University) - www.tamilvu.org
2. தமிழ் விக்கிப்பீடி (Tamil Wikipedia) - https://ta.wikipedia.org
3. தர்மபுரா ஆதீனதவளியீடு
4. வொழ்வியல் களஞ்சியம் - தமிழ்ப் பல்ககலக்கழகம்,தஞ் ஊவூர்
5. அரிசியம் களஞ்சியம் - தமிழ்ககல் களஞ்சியம் (thamilvalarchithurai.com)
6. அரிசியம் களஞ்சியம் - தமிழ்ப்பல்ககலக்கழகம்,தஞ் ஊவூர்