M.Tech
Production Engineering and System Technology
(2020-22)

Scheme of Teaching and Examination
&
Syllabus

Department of
Industrial & Production Engineering

THE NATIONAL INSTITUTE OF ENGINEERING
### I SEMESTER

**M.Tech-PRODUCTION ENGINEERING AND SYSTEM TECHNOLOGY (PEST)**

Department of Industrial and Production Engineering

Scheme of Teaching (Autonomous Scheme)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Course Code</th>
<th>Course</th>
<th>Contact Hrs. / Week</th>
<th>No. of Credits</th>
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**Total number of credits**  
27

**Contact hours per week**  
30

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**Elective-I**

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**Total number of credits**

27

**Contact hours per week**

30

#### Elective-III

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### IV SEMESTER

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I Semester M.Tech [4-0-0]
(Common to IAR, NT, MD & PEST)
Applied Mathematics

Sub Code : APM1C01
Hrs/Week : 04
SEE Hrs : 03

CIE : 50% Marks
SEE : 50% Marks
Max. : 100 Marks

Course outcomes:
On successful completion of the course the students will be able to:
1. Apply matrix and iterative methods to solve a system of linear algebraic equations.
2. Apply geometry of Linear transformations and construct orthonormal basis of an inner product space.
3. Diagonalising a matrix by finding the eigen values and the corresponding eigen vectors, compute the smallest and the largest eigen values and also singular values.
4. Use statistical tools to draw inferences for the given data.
5. Solve problems associated with continuous joint probability distribution, Markov chain using transition probability matrix and concept of queuing theory.
6. Use optimization techniques to solve linear and non-linear programming problems.

Module 1
Linear Algebra - 1
Solution of system of linear algebraic equations, Triangularization method, Cholesky’s method, Partition method, Gauss Seidel iterative method

SLE: Gauss elimination method.

Module 2
Linear Algebra - 2

SLE: Least square problems.

Module 3
Linear Algebra - 3
Eigen values & Eigen vectors, diagonalization of a matrix, Jacobi’s method for diagonalisation of symmetric matrices, Power method, Inverse power method. Singular Value Decomposition.

SLE: Properties of eigen values and eigen vectors.

Module 4
Sampling Theory
Random sampling, Sampling distributions, Parameter estimation, Testing of hypothesis, Analysis of variance, Significance tests

SLE: Correlation and Regression.

Module 5
Probability
Joint probability distribution (Continuous), Markov chains – probability vector, stochastic matrix, transition probability matrix, Concept of queuing – M/M/1 and M/G/1 queuing system
SLE: Discrete joint probability distribution.  

Module 6
Optimization
Standard form of LPP, Simplex method, Big-M method, Duality, Non-Linear programming problems
SLE: Degeneracy in simplex method

References:
1. Linear Algebra – Larson & Falvo (Cengage learning)
4. Probability and Statistics – Schaum Series (All latest editions)
MATERIAL REMOVAL PROCESSES (4:2:0)

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**Course Outcomes:**

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

1. Identify the characteristics of traditional metal removal technique and be able to analyze theories associated with it, facilitating them to identify research topics in the field.
2. Select appropriate cutting tools for specific use, knowing the characteristics of the same.
3. Explain the heat sources during metal cutting and model the same; able to select cutting fluids.
4. Identify the general characteristics of non-traditional metal removal processes and the principle of operation of mechanical processes; able to identify the research topics in the field.
5. Explain the principle of operation and the parameters influencing MRR for thermal metal removal processes and identify the research topics.
6. Explain the engineering application of electrochemical processes knowing well the principle of operation and the parameters involved.

**Module 1**

**Mechanics of Metal Cutting:** Introduction, terms and definitions, chip formation, the forces acting on the cutting tool and their measurement, specific cutting energy, plowing force and the "size effect", the apparent mean strength of the work material, chip thickness, theory of Ernst and Merchant, Theory of Lee and Shaffer, experimental evidence, friction in metal cutting, analytical modeling of machining, slip line field analysis, finite element analysis.

**High Speed Machining:** Introduction, Mechanics of chip formation, high speed machining parameters, cutting tool materials, applications. Implementing high speed machining, future needs. **10 Hrs.**

**SLE: Machining of composites difficulties and possible solutions.**

**Module 2**

**Mechanics of Hard Machining:** Cutting tools for hard machining, mechanical models of hard machining, cutting forces, cutting energy, influence of supply of minimum quantity of lubricant on mechanical behaviour of hard machining, criteria for shear instability, material side flow effect.

**Tool Materials and their properties:** Single and multipoint cutting tools, tool nomenclature, tool angle specification in ASA system, characteristics of tool materials, types of tool materials-carbon tool steels, high speed steels, cast alloys, cemented tungsten carbides, Inserts and their designation, ceramic and cermet tools, coated tools, coating materials, CVD and PVD techniques, super hard tool materials, cubic boron nitride (CBN), polycrystalline
diamonds (PCD) and recent cutting tools. Recommended cutting parameters for the above tools 10Hrs

**SLE: Tool holder nomenclature for turning, milling and hole making tools.**

**Module 3**

**Thermal aspects and cutting fluids:** Introduction, heat sources in metal cutting, shear plane temperature in orthogonal cutting, factors influencing tool temperature, experimental determination of tool temperature, types of cutting fluids, composition of cutting fluids. 

**Tool Wear and Tool life** – Mechanisms of tool wear, sudden and gradual wear, crater wear, flank wear, tool failure criteria, tool life equations, effect of process parameters on tool life, tool life tests, conventional and accelerated tool wear measurement.

**SLE: Selection and applications of cutting fluids, Application of semi-liquid lubricants Mach inability index.**

**Module 4**

**Non-traditional Machining** – processes, need, classification and selection Mechanical process, Ultrasonic machining, Abrasive jet machining, principle of operation, process parameters, material removal rate, characteristic curves, modeling, applications of Ultrasonic machining and Abrasive jet machining processes.

**SLE: Water Jet Machining, principle of operation, parameters and characteristics curves, applications.**

**Module 5**

**Thermal Removal Process** – Electric Discharge Machining (EDM), principle, mechanism of metal removal, types of circuits, material removal rate, critical resistance, Process parameters, applications. wire cut EDM, applications. Laser Beam Machining and Electron Beam Machining – principle of operation, applications, advantages and disadvantages.

**SLE: Principle of operation of Plasma arc machining**

**Module 6**

**Electro chemical Machining Process** – Principle of operation, chemistry of ECM process, process parameters, determination of MRR, dynamics and hydrodynamics of the process, applications, advantages and disadvantages. Chemical machining – principle, advantages, disadvantages and application.

**SLE: Electrochemical Grinding, principle of operation, advantages, disadvantages and applications**
References:


AUTOMATED MANUFACTURING SYSTEMS (4:2:0)

Sub Code : MPT1C02
Hrs/Week : 06
SEE Hrs : 03

CIE : 50% Marks
SEE : 50% Marks
Max. Marks : 100

Course Outcomes:

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

1. Identify the elements of production systems and manufacturing support systems.
2. Explain the basic elements and controlling systems of automation.
3. Comprehend manufacturing systems.
4. Analyze manual assembly lines.
5. Analyze automated production and assembly lines.
6. Apply appropriate inspection procedure to produce good quality components and to understand the basic AI and its techniques.

Module 1

Introduction: Production systems, Manufacture support system, Automation in production systems, Manual labour in production systems, Automation principles and strategies, Manufacturing operations, Manufacturing industries and products. 06 Hrs

SLE: Manufacturing operations, Production facilities, Product/production relationship, Lean production

Module 2

Introduction to Automation: Basic elements of an automated system, Advanced automation Functions, Levels of automation.

SLE: Hardware components for automation and process control

Module 3

Manufacturing Systems: Introduction, Components of a manufacturing system, Classification scheme for manufacturing system
Single-Station Manufacturing Cells: Single-Station manned cells - Single-station automated cells, Application of single station cells. 08 Hrs

SLE: Case studies on material handling system, Analysis of single station systems.
Module 4:
08 Hrs

SLE: Workstation Considerations.

Module 5:
Automated Production Lines: Fundamentals of automated production lines, Work part transfer mechanisms, Storage buffers, Control of production line, Applications of automated production lines.
Automated Assembly Systems: Fundamentals of automated assembly systems, Parts delivery at workstations
Quantitative Analysis of Assembly systems: Multi-station assembly machines, Single station assembly Machines, Partial automation.  
12 Hrs

SLE: Analysis of transfer lines with or without internal parts storage.

Module 6:
Inspection Principles and Practices- Inspection fundamentals, Sampling versus 100% inspection, On-line and off-line inspection, Quantitative analysis of inspection.
Artificial Intelligence : AI, the AI problems, the underlying assumption, AI techniques, the level of the model, criteria for success, some general references, goals of AI research.  
09 Hrs

SLE: Automated inspection, Production system characteristics with AI.

References:

CORPORATE FINANCE (4:0:0)

Course Code: MPT1C03
Hrs/Week : 04
SEE Hrs : 03

CIE : 50% Marks
SEE : 50% Marks
Max. Marks : 100

Course outcomes:
Upon successful completion of this course the student will be able to:

1. Recall the basic concepts of financial management and financial statements.
2. Recall the basic concepts of financial statements and interpret different techniques applicable to capital budgeting.
3. Understand CVP analysis and Working Capital Management
4. Understand different types of budgets and how to prepare budgets
5. Interpret different sources of finance and venture capital.
6. Understand the concept of dividend policies, mergers and acquisitions.

Module 1
Introduction: Evolution of financial management, goals, scope, objectives. Financial decisions in a firm, principle of finance, value and return, risk and return. 08 Hrs

SLE: Forms of Business.

Module 2
Financial statements - Balance sheet, profit and loss account, ratio analysis.
Capital Budgeting: Techniques and problems. 8 Hrs

SLE: Process of capital budgeting.

Module 3
Concept of Cost-Volume-Profit: (CVP) analysis, cost of capital, Problems
Working Capital Management: Determination of operating cycle and working capital. 8 Hrs

SLE: Essentials of Budgeting and determinants of working capital.

Module 4
Budgets: Purposes of budgeting, types of budgets, problems. 10 Hrs.

SLE: SEBI guide lines on capital issues, stock market in India.
Module 5
Long Term Finance: Shares, debentures and term loans, primary and secondary markets, mutual funds, convertible debentures.

SLE: venture capital

Module 6
Dividend Policy: Reasons for payment of dividends, dividend policy, forms of dividends, cash dividend, bonus shares - stock splits and buyback of shares.
Mergers and Acquisitions: Reasons, mechanics, portfolio management, international financial management.

SLE: Dividend policies in practice.

Text Books:

References:
RESEARCH METHODOLOGY (2:0:0)

Course Code : MPT1CRM
Hrs/Week : 02
SEE Hrs : 02

CIE : 50% Marks
SEE : 50% Marks
Max. Marks : 50

Course Outcomes:

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

1. Plan experiments according to a proper and correct design plan.
2. Analyze and evaluate experimental results (statistically), according to chosen experimental design.
3. Control and properly use fundamentals such as hypothesis testing, degrees of freedom,

Module-1
Basic Concept: Types of research, Research approach, Significance of research, Research framework, Case study method, Experimental method, Sources of data, data collection using questionnaire and interviewing.

Research Formulation: Components, selection and formulation of a research problem, objectives of formulation and criteria of a good research problem
SLE: Develop a scientific study for carrying out research 10Hrs

Module-2
Research Hypothesis: Criterion for hypothesis construction, nature of hypothesis, need for having a working hypothesis, characteristics and types of hypothesis, procedure for hypothesis testing.

Sampling Methods: Introduction to various sampling methods and their applications
SLE: Apply the appropriate statistics methods/tools on suitable research problems 10 Hrs

Module-3
Data Analysis: Sources of data, collection of data, measurement and scaling technique, and different techniques of data analysis.

SLE: Novelty in writing high impact journal articles 10 Hrs

Text Books:

Reference Books:

ELECTIVE I

INDUSTRIAL DESIGN AND ERGONOMICS (3:0:0)

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

1. Demonstrate familiarity with theoretical concepts explaining human cognitive functioning relating to the study of work and evaluate situations and recommend decisions in designing of work place
2. Understand and apply ergonomic principles to design displays and controls for safer efficient and effective utilization.
3. Recognize and value the diversity of human vision in product design.
4. Identify and use appropriate colors in workplace layout and engineering equipment design.
5. Apply aesthetic concept for designing product.

Module 1
Introduction: An approach to Industrial Design, Industrial design in engineering application in modern manufacturing systems.

Ergonomics and Industrial Design and Production: Introduction to Ergonomics, Communication system, general approach to the man-machine relationship, Human component of work system, Machine component of work system. Anthropometric data and its applications in ergonomic, working postures, Body Movements, Work Station Design, Chair Design.


Module 2
Displays: Design Principles of Visual Displays, Classification, Quantitative displays, Qualitative displays, check readings, Situational awareness, Representative displays, Design of pointers, Signal and warning lights, colour coding of displays, Design of multiple displays
Controls: Design considerations, Controls with little efforts – Push button, Switches, Rotating Knobs. Controls with muscular effort – Hand wheel, Crank, Heavy lever, Pedals.
Design of controls in automobiles, Machine Tools

SLE: Design and drawing of domestic and industrial displays and controls.

Module 3
Visual Effects of Line and Form: The mechanics of seeing, Psychology of seeing, Figure on
ground effect, Gestalt’s perceptions - Simplicity, Regularity, Proximity, Wholeness. Optical illusions, Influences of line and form

SLE: Parts of Eye, structure of cones and rods.

Module 4
Colour: Colour and light, Colour and objects, Colour and the eye – after Image, Colour blindness, Colour constancy, Colour terms – Colour circles, Munsell colour notation, reactions to colour and colour combination – colour on engineering equipments, Colour coding, Psychological effects, colour and machine form, colour and style.

SLE: Use of colours in industries.

Module 5
Aesthetic Concepts: Concept of unity, Concept of order with variety, Concept of purpose, Style and environment, Aesthetic expressions - Symmetry, Balance, Contrast, Continuity, Proportion. Style - The components of style, House style, Style in capital good.

SLE: Golden ratio and use of aesthetics in design.

References Books:

ROBOTICS FOR INDUSTRIAL AUTOMATION (3:0:0)

Sub Code : MPT1E102  CIE : 50% Marks
Hrs/Week : 03  SEE : 50% Marks
SEE Hrs : 3Hrs  Max. Marks : 100

Course Outcome:

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

1. Explain 3D translation and orientation representation
2. Understand the trajectories of Robot arm motions
3. Apply localization and mapping aspects of mobile robotics.
4. Design and simulate a robot to meets kinematic requirements.
5. Illustrate the use of Robot Operating System usage, sensors, actuator and programming.

Module 1:

Introduction: Definitions, Types of Robots, Application of Robots, Representing Position and Orientation, Representing Pose in 2-Dimensions, Representing Pose in 3-Dimensions, Representing Orientation in 3-Dimensions, Combining Translation and Orientation. 8 Hrs

SLE: Mat lab program for translation and orientation

Module 2:

Time and Motion: Trajectories, Smooth One-Dimensional Trajectories, Multi-Dimensional Case, Multi-Segment Trajectories, Interpolation of Orientation in 3D, Cartesian Motion, Time Varying Coordinate Frames, Rotating Coordinate Frame, Incremental Motion, Inertial Navigation Systems. Mobile Robot Vehicles, Mobility, Car-like Mobile Robots, Moving to a Point, Following a Line, Following a Path, Moving to a Pose 8 Hrs

SLE: Flying Robots

Module 3:


SLE: Mat lab programming of localization
Module 4:

**Robot Arm Kinematics:** Describing a Robot Arm, Forward Kinematics, A 2-Link Robot, A 6-Axis Robot, Inverse Kinematics, Closed-Form Solution, Numerical Solution, Under-Actuated Manipulator, Redundant Manipulator, Trajectories, Joint-Space Motion, Cartesian Motion, Motion through a Singularity.  

**SLE: Joint Angle Offsets, Determining Denavit - Hartenberg Parameter**  

9 Hrs

Module 5:

**Getting Started with ROS:** Installing ROS, Understanding the ROS File system level, Packages, Stacks, Messages, Services, Understanding the ROS Computation Graph level, Nodes, Topics, Services, Messages, Bags, Master, Parameter Server, Creating workspace, Creating & Building an ROS package, Creating & Building the node, Visualization of images, Working with stereo vision, 3D visualization.  


**SLE: Saving and playing back data in ROS.**  

9 Hrs

Tutorial Component:

1. Matlab Introduction Basic  
2. Arduino programming for Robot Control  
3. Robotic simulation through Scorbot  
4. Mobile Robot Control and application of Artificial Intelligence  
5. Robot Arm Manipulator Control  
6. Kuka Robot Programming

References:

DESIGN FOR MANUFACTURING (3:0:0)

Sub Code  : MPT1E103   CIE      : 50% Marks
Hrs/Week  : 03         SEE      : 50% Marks
SEE Hrs   : 03          Max. Marks : 100

Course Outcomes:
Upon successful completion of this course the student will be able to:

1. Understand DFM and tolerancing.
2. Understand datum features.
3. Appreciate design consideration in manufacturing.
4. Understand machining considerations in design of a component.
5. Design gauges for checking components in assembly.

Module 1
Effect of Materials, Manufacturing Process and Design: Major phases in design and Manufacture, Effect of material properties on design, Effect of manufacturing process on design, Cost per unit property and Weighted properties methods.
Tolerancing: Tolerance specification and representation of various tolerances, their significance in assembly, Geo-material tolerances for assembly line - True position tolerancing, Cumulative effect of tolerances in assembly, Interchange ability and selective assembly in manufacturing, Process capability and its significance with reference to tolerancing.

SLE: Material selection process, achieving larger machining tolerances.
10 Hrs

Module 2
Datum Features: Functional datum, Datum for manufacturing.

SLE: Changing the datum.
08 Hrs

Module 3
Design Considerations: Design of components with casting considerations, Pattern, Mould, and Parting line, Cored holes and Machine holes, Identifying the possible and probable parting line, Designing to obviate sand cores.

SLE: Castings requiring special sand cores.
08 Hrs

Module 4
Component Design: Component design with machining considerations like design for turning components-milling, drilling and other related processes.

SLE: Finish-machining operations.
08 Hrs
Module 5

**Design of Gauges:** Design of gauges for checking components in assembly with emphasis on various types of limit gauges for both hole and shaft.  

08 Hrs

*SLE: Case studies.*

**References:**

DIMENSIONAL METROLOGY AND QUALITY ENGINEERING (2:0:2)

Sub Code : MPT1E105
Hrs/Week : 04
SEE Hrs : 03

CIE : 50% Marks
SEE : 50% Marks
Max. Marks : 100

Course Outcomes:

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

1. Understand the laser metrology technique.
2. Explain the Holography measurement technique.
4. Identify the importance of Quality in Manufacturing and Design Engineering.
5. Understand the need for Quality Management System and Continuous Improvement.

Module 1
Laser Metrology: Free electron laser – Optical alignment, Measurement of distance – Interferometry, Reversible counting, Refractive index correction, reversible counting, Refractive index correction, surface topography and optical component testing, Beam modulation telemetry, Pulse-echo techniques, Surface velocity measurements using speckle patterns - Laser spectroscopy - Modular beam spectroscopy, Saturation spectroscopy. 08 Hrs

SLE: Two Photon Spectroscopy.

Module 2
Holography: Basic principles - Holographic interferometry - Double exposure holographic interferometry – Sandwich holograms, Real time holography. 08 Hrs

SLE: Time-average holographic interferometer Character recognition.

Module 3
Coordinate Measuring Machine (CMM) and Machine Vision: Fundamental features of CMM, Development of CMMs, Role Of CMMs, Types of CMMs, Modes of operation, Types of probes, Probe calibration, Non-contact type probes, Direct computer control, Software packages, Operational modes, Metrological features, Co-Ordinate systems, portable arm CMMs, Machine vision systems, Illumination, Magnification. 10 Hrs

SLE: Vision system measurement – Multi sensory systems.

Module 4

Quality in Design Engineering: Opportunities for improvement product design, Early warning concepts and design assurance, Designing for basic functional requirements, Designing for time oriented performance (reliability), Availability, Designing for safety, Designing for manufacturability, Cost and product performance, Cost of quality, Design
review, Concurrent engineering.

**SLE: Quality and production floor culture.**

**Module 5**

**Quality Management System:** Need for quality management system, Design of quality management system, Quality management system requirements, ISO 9001 and other management systems and models, Improvements made to quality management systems.

**Continuous Improvement:** Basic quality engineering tools and techniques, Statistical process control - Techniques for process design and improvement, Taguchi methods for process improvement.

**SLE: Six sigma - the ‘DRIVE’ framework for continuous improvement.**

**References:**

## ELECTIVE II

**THEORY OF METAL FORMING (3:0:0)**

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### Course Outcomes:

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

1. Understand the processes involved in metal forming mechanics, materials and tribology.
2. Understand the stress involved in drawing wire and tube to predict the load required.
3. Analyze the extrusion load by understanding the variables of extrusion process.
4. Understand the forging process to reduce the problems of metal flow associated with the filling of complex die shapes.
5. Explain the quantitative prediction of rolling loads from which detailed optimum rolling schedules may be prepared.

### Module 1:

**Forming process:** Introduction to metal forming classification, Effect of temperature on forming process-hot working and cold working, True stress and strain, Strain energy, Yield criterions, Tresca yield criteria, Von Mises yield criterion, Relationship between tensile yield stress and shear yield stress, Yield under plane-Strain condition, 08 Hrs

**SLE:** Effect of metallurgical structure, Frictional contribution in metal forming process, Effect of speed on deformation, Work of plastic deformation.

### Module 2:

**Drawing:** Drawing of wide strip through wedge shaped dies by local stress evaluation, Principles of rod and wire drawing, Variables in wire drawing, Drawing load determination for circular rod with a conical die from local stress evaluation, Tandem drawing process, Optimum die angles, tube drawing process, determination by stress evaluation of the load for close pass drawing of thin walled tube - with slightly tapered plug and with moving a mandrel, Tube sinking. Residual stresses in rod, Redundant work in tube drawing. Defects in rod and wire drawing, 10 Hrs

**SLE:** Forming methods shearing, blanking, deep drawing, stresses in a section of drawn cup Redrawing operations, defects in deep drawing

### Module 3:

**Extrusion:** Classification, Extrusion equipments, Variables of extrusion process, Stress evaluation for extrusion of round bar and flat strip, Allowance for container friction, deformation in Extrusion. Impact extrusion, extrusion defects, work done in extrusion, 8 Hrs

**SLE:** Bending, Spring back and compensation stretch forming, Defects in formed products.
Module 4:  
**Forging**: Classification, Various stages during forging. Forging equipments, Determination of plane strain compression load during forging a plate and flat circular disc from local stress evaluation, High friction condition.  
08 Hrs

**SLE**: Forging defects. Residual stresses in forging.

Module 5:  
08 Hrs

**SLE**: High Strain energy forming methods: Rubber forming, Electro hydraulic forming, Explosive forming, Magnetic forming.

References :


TOOL DESIGN (3:0:0)

Sub Code : MPT1E202  CIE : 50% Marks
Hrs/Week : 03  SEE : 50% Marks
SEE Hrs : 03  Max. Marks : 100

Course Outcomes:
Upon successful completion of this course, the students will be able to:
1. Explain the basics of tool design method, tool making practices, material used for tooling and heat treatment methods to be used.
2. Design cutting tools used in machining process, and tool for inspection and gauging.
3. Illustrate the principles of locating and clamping so as to design drill, jigs and fixtures.
5. Explain the features of tooling required for joining and casting process and define the procedure of tooling required for NC machine tools

Module 1:
Tool-design Methods: Introduction, The design procedure, Drafting and design techniques in tooling drawing.
Tool-making Practices: Introduction, Tools of the tool maker, Hand finishing and polishing, screws and dowels, Hole location, Jig-boring practice, Installation of drilling bushings, Punch and die bushings, Punch and die manufacture, EDM, Tracer and duplicating mills for cavity applications, Low-melting tool materials.

SLE: EDM for cavity applications.

Module 2:
Design of Cutting Tools: Introduction, The metal cutting process, Revision of metal cutting tools-Single point cutting tools, Milling cutters, Drills and Drilling, Reamers, Taps. Selection of carbide tools, determining the insert thickness for carbide tools.

SLE: Selection of material for gages.

Module 3:
Locating and Clamping Methods: Introduction, Basic principle of location, Locating
methods and devices, Basic principle of clamping.

**Design of Drill Jigs:** Introduction, Types of drill jigs, General considerations in the design of drill jigs, Drill bushings, Methods of construction.

**Design of Fixtures:** Introduction, Types of fixtures, Fixtures and economics. 10 Hrs

**SLE: Drill jigs and modern manufacturing.**

**Module 4:**

**Design of Press-working Tools:** Power presses, Cutting operations, Types of die-cutting operations - and their design, Evolution of blanking and progressive blanking.

**Design of Sheet Metal Bending, Forming and Drawing Dies:** Introduction, Bending dies, Forming dies, and Drawing dies. Evolution of a draw die, Progressive dies. Strip development for progressive dies, Examples of progressive dies. Extrusion dies, Drop forging dies and auxiliary tools, Problems. 10Hrs

**SLE: Selection of progressive dies.**

**Module 5:**

**Tool Design for Joining Processes:** Introduction, Tooling for physical joining processes, Tooling for soldering and brazing, Tooling for mechanical joining processes, Problems.

**Tooling for Casting:** Introduction, Tooling for sand casting, Metal moulding and die-casting, Problems

**Tool Design for NC Machine Tools:** Revision of NC control, Fixture design for NC machine tools, Cutting tools and tool-holding methods, Automatic tool chargers and tool positioners. 06Hrs

**SLE: Shell Moulding.**

**References Books:**


ADDITIVE MANUFACTURING (3:0:0)

Sub Code : MPT2E203  
Hrs / Week : 03  
SEE Hrs : 3 Hrs 

CIE : 50 % Marks  
SEE : 50 % Marks  
Max. Marks : 100

Course Outcomes:
Upon successful completion of this course, the student will be able to:

1. Comprehend the growth of Rapid Prototyping Techniques and their advantages.
2. Compare the principle of operation for Stereo lithography, Selective Laser sintering, fused deposition modelling, solid ground curing and laminated object manufacturing processes.
3. Understand Solid Ground Curing and Laminated Object Manufacturing
4. Evaluate different Concept Modelers and distinguish direct and indirect tooling systems for Rapid Prototyping
5. Optimize the factors influencing rapid prototyping process.

Unit 1:  
Introduction: Need for the compression in product development, history of RP systems, Survey of applications, Growth of RP industry.  
Self Learning Exercise: classification of RP systems  

Unit 2:  
Selective Laser Sintering and Fusion Deposition Modeling: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, process parameter, Path generation, Applications.  
Self Learning Exercise: Principle of Fusion deposition modeling  

Unit 3:  
Self Learning Exercise: LOM materials  

Unit 4:  
Concepts Modelers: Principle, Thermal jet printer, Sander's model market, GenisysXs printer HP system 5, Object Quadra systems.  

Dept. of Industrial and Production Engg, NIE, Mysuru
**Rapid Tooling:** Indirect Rapid tooling - Silicone rubber tooling– Aluminium filled epoxy tooling Spray metal tooling, Cast kirksite, 3Q keltool, etc. Direct Rapid Tooling Direct. AIM, Quick cast process, Copper polyamide, Rapid Tool, DMILS, Prometal, Sand casting tooling.  

**Self Learning Exercise:** 3-D printer, Laminate tooling soft Tooling vs. hard tooling

**Unit 5:**

**RP Process Optimization:** factors influencing accuracy. Data preparation errors, Part building errors, selection of part build orientation.  

**Self Learning Exercise:** Error in finishing.  

**Text Books:**


**Reference Books:**


SURFACE TREATMENT AND FINISHING (3:0:0)

Course code : MPT1E204
Hrs/Week : 03
SEE Hrs : 03

CIE : 50% Marks
SEE : 50% Marks
Max. Marks : 100

Course Outcomes:
Upon successful completion of this course the student will be able to:

1. Outline the importance of surface treatment and its use in industries.
2. Summarize the concepts of surface treatment.
3. Select an appropriate surface treatment process for its end use.
4. Outline the plastic coating of metals.
5. Examine a coated surface for viability review the advanced surface coating techniques.

Module 1
Introduction to Surface Treatment: Industries using surface treatments, Industry structure and economic background, Specific industry activities, other emissions. 08Hrs

SLE: Key Environmental Issues.

Module 2
Surface preparation and Pre Treatment: Objective of surface preparation and the phenomena, Mechanical surface preparation, Flame cleaning, Blast cleaning, Chemical surface preparation, Solvent wiping and degreasing, Alkali cleaning, Emulsifiable solvent cleaning, Steam cleaning, Acid cleaning, Pickling, Phosphoric acid. 08Hrs

SLE: Electrolytic Pickling.

Module 3

Vacuum Coating: PVD and CVD Metal spraying-Methods, Surface preparation, Mechanical properties of sprayed metals, plasma coating 08Hrs

SLE: Diamond like coating and coating on carbides .

Module 4
Plastic Coating of Metals: Pre-treatment of plastics (etching), Conditioning of plastics, Etching or pickling of plastic, PVC coating, Spherodising process details, Phosphate coating, Mechanism of formation. 08Hrs

SLE: Electro plating of Plastics.
Module 5

Testing of Surface Coating Methods

Heat treatment methods: Annealing, Normalizing, Tempering, Case hardening methods, Flame Hardenning, sub zero treatment. Quench polish Quench (QPQ) and Plasma nitriding.

Heat Treatment Methods: for gears, spindles and cutting tools.

Advanced Coating Technologies: Hard facing, Electro deposition technique 08Hrs

SLE: Nano coatings, Coating Characterization, cladding

References:

MANUFACTURING SYSTEMS LABORATORY-I (0:0:2)

Course Code: MPT1L01
Hrs/Week: 02
SEE Hrs: 03

CIE: 50% Marks
SEE: 50% Marks
Max. Marks: 100

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

1. Evaluate the performance of cutting tools in machining mild steel and cast iron by monitoring cutting forces, cutting temperature and the like.
2. Arrive at the tool life equation for cutting tools.
3. Carry out Mach inability studies in EDM
4. Make use of PLC for machine tool control

Lab -1

1. To determine the cutting forces during turning, drilling and milling and draw the characteristic curves
2. To establish the cutting forces during grinding and draw the characteristic curves
3. To determine the cutting ratio during orthogonal cutting operation
4. Establish the cutting temperature during turning operation at various cutting conditions using tool work piece thermocouple circuit
5. To carry out Mach inability studies during electric discharge machining operation
6. To evaluate the performance of HSS and W-C tools in machining.
7. To arrive at Tool- Life equation for cutting tools.

Lab -2

1. Accepting inputs from switches and powering on specific outputs
2. Accepting input from sensors and powering on specific outputs
3. Accepting inputs to PLC and powering the outputs after some specified delay
4. Implementing counter function in PLC
5. Accepting analog inputs from potentiometer and displaying the scaled value on HMI (Human Machine Interface).
6. Programming robot for point to point motion and gripper close operation with endless loop
7. Programming robot for point to point motion, gripper close and wait operation with endless loop
8. Programming robot for linear and circular operation
II SEMESTER
(Core Courses)

FINITE ELEMENT ANALYSIS (4:2:0)

Course Code : MPT2C02  
CIE : 50% Marks

Hrs/Week : 06  
SEE : 50% Marks

SEE Hrs : 03  
Max. Marks : 100

Course Outcome:
Upon successful completion of this course, the students will be able to:
1. Formulate the three dimensional stress, strain equations using theory of elasticity.
2. Evaluate engineering problems by Rayleigh-Ritz method.
3. Solve the 1D problem using FEM.
4. Solve the trusses and beam problems using FEM.
5. Solve the 2D problem by FEM.
6. Formulate the vibration of machine elements and structures using FEM.

Module 1
Introduction to FEM and Theory of Elasticity: Basic procedure of FEM, Theory of Elasticity, and 3D and 2D equations of equilibrium, principle stresses and strains, equations in cylindrical and polar coordinates. Axis symmetric bodies. Strain analysis, stress strain relations and generalized hooks law, plane stress and plane strain problems, and strain energy.  
SLE: Theories of failures, Saint Venant’s principle.

Module 2
Basic Concept of FEM: Discritization of continuum, finite elements, Nodes, DOF, shape functions of 1D, 2D and 3D elements. Higher order elements, linear, quadratic and cubic shape functions, sub parametric, iso-parametric and super parametric concepts. Local and global coordinate system and element characteristics, polynomial function and Pascal triangle. Principle of Potential. Energy and Rayleigh Ritz method.  
SLE: Principle of virtual work and Gelarkin method.

Module 3
One Dimensional Analysis: Bar elements with linear shape functions – B matrix K matrix – Body force and load vector – Assembly and Boundary conditions – Elimination approach – Solution to overall equation, calculation of stresses and other results, Numerical Problems, Penalty approach, Discussion of Bar element with Quadratic shape function.  
SLE: Discussion on convergence of finite element solution, characteristics of [K] and computer storage.
Module 4
**Truss Element and Beam Element:** Local and Global Coordinate system, Transformation matrix. Stiffness matrix and assembly, stress calculation. Temperature stresses, numerical problems on simple truss structures. Equation of bending, potential energy function. Simple beam element and DOF – Hermite shape functions – K matrix and load vectors, – shear force and bending moment vectors.

**SLE: Elementary Beam Theory.**

Module 5
**Two and Three Dimensional Analysis:** 2 D stress strain relations, constant strain triangle, nodes, DOF, displacement functions – Jacobian and B Matrix, Expression for $K^e$–Load vectors – stress calculation – temperature effects – Problems, modelling and Boundary conditions – simple problems, Axi-symmetric elements and its applications 3 D stress strain relationship, Shape functions , Jacobin Matrix , K – Matrix , problem Modelling. **07 Hrs**

**SLE: Tetrahedral and Hexahedral elements.**

Module 6
**Dynamic Analysis:** Introduction to vibration and Basic definitions. Potential energy and Kinetic energy of vibrating bodies. Lagrangian and Hamilton principle. Equation of motion using Lagrangian operator.

**FEA of Metal Forming Problems:** Modeling of forging process, derivation of governing equation and boundary conditions, Computer implementation, Interpretation of results, extending this model to other metal forming problems **10 Hrs**

**SLE: classification and description of metal forming processes**

**Tutorial component:**
1. Analysis of stresses in bar and truss for different load condition.
3. To a established temperature distribution in the weldment after the welding process.
4. To a established temperature distribution during orthogonal cutting operation.
5. Determine the Von Misses stresses for a machine component subjected to combined loading.

**References:**
5. Introduction to Finite Element Method, Chandrakantha S. Desai, John F. Abel East, West publication.
FLUID POWER AUTOMATION (4:2:0)

Course Code: MPT2C05
CIE : 50% Marks
Hrs/Week : 06
SEE : 50% Marks
SEE Hrs : 03
Max. Marks : 100

Course Outcome:
Upon successful completion of this course, the students will be able to:
1. Identify fluid power components and working of energy converters.
2. Identify the various control components used for fluid power system.
3. Create and analyse electro hydraulic circuits for various applications.
4. Identify the various valves and other components used for pneumatics application.
5. Create and analyze pneumatic circuits and logic function for various applications.
6. Create advanced pneumatic circuits for various applications.

Module 1
Hydraulics systems: Introduction, Pascal law, advantages and applications of fluid power, components of a fluid power system, pumping theory, pump classification, gear pumps, vane pumps- simple, balanced and pressure compensated vane pump, vane design, piston pumps-radial, axial (bent axis and swash plate), pump performance, ripple in pumps.
Linear actuator- cylinders, mechanics of hydraulic cylinder loading, limited rotation hydraulic actuator, cylinder cushioning, motor performance, hydrostatic transmission and its performance 10Hrs

SLE: Pump Noise, Gear, Vane and Piston motor.

Module 2
Valves: Directional Control Valves- 2/2, 3/2, 4/2 and 4/3 ways DCV’s, centre configurations in 4/3 way valves, actuation of DCV’s, solenoids for valve actuation, indirect actuation, relays, delay relay, limit switches, relay circuit design, sensors-contact, non contact type, magnetic reed switch, optical type, proximity sensors, valve lap – lap during stationary and during switching.
Pressure Control Valves: classification, opening and closing pressure difference, cracking pressure, pressure relief valve – simple and compound type, pressure reducing valve, pressure switches.
Flow Control Valves: fixed throttle, variable throttle, pressure compensations principles, pressure compensated flow control valves – reducing and relief type. check valve, pilot operated check valve, throttle check valve. 12 Hrs

SLE : Proportional valve technology, proportional solenoids, proportional directional valves, proportional pressure control valves.
Module 3
**Electro Hydraulic Circuit Design and Analysis:** control of single and double acting cylinder using 4/2 and 4/3 solenoid valves, regeneration circuit, counterbalance application, cylinder sequencing and synchronizing circuit, continuous cylinder reciprocation using proximity sensors, speed control of cylinder and motors, relay circuit design for electro hydraulics for different application, cylinder reciprocation using delay relay, accumulators and accumulator circuits  
08 Hrs

**SLE:** Servo valve technology, torque motor, single and multistage servo valves.

Module 4
**Pneumatic System:** Introduction, pneumatic cylinder and air motor – different types of cylinder, cushion assembly, directional control valves- limit switches type, impulse valve, memory valve, pressure regulator, flow control valve, check valve, pilot check valve, throttle check valve, quick exhaust valve, shuttle valve, twin pressure valve, reflex nozzle, time delay valve  
08 Hrs

**SLE:** Generation and preparation of compressed air, air receiver, servicing FRL Module, Air filter, pressure regulation, lubricator.

Module 5
**Design of Pneumatic Circuit and Logic Circuits:** Control of single and double acting cylinder, impulse operation, speed control- supply air and exhaust air throttling, circuit design, NOT, YES, AND, OR, NAND, NOR function, logic circuits design using shuttle valve and twin pressure valve, application circuits using logics.will, travel, time and pressure dependent pneumatic circuit, practical examples involving these controls, signal overlapping and its elimination, cascading circuits.  
08 Hrs

**SLE:** Sequencing circuits and its applications and pressure dependent controls.

Module 6
**Electro Pneumatics:** Contactors and Switches, relays, proximity switches, Pneumatic cylinder reciprocation using proximity switches, Electro Pneumatic circuit design for different applications, time delay circuits using delay relays.  
06Hrs

**SLE:** Use of Kannaugh- Veitch map for pneumatic circuit design.

**References:**
4. Hydraulics Trainer- Vol 1, Components and application, Rexroth - Bosch Publication.
MICRO MACHINING (4:0:0)

Course Code: MPT2C06  
CIE : 50% Marks  
Hrs/Week : 04  
SEE : 50% Marks  
SEE Hrs : 03  
Max. Marks : 100

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

1. Understand mechanical advanced micromachining processes and thermal advanced micromachining processes
2. Understand Molecular Dynamics (MD) Simulations of Machining at the Atomistic Scale
3. Understand Diamond Turn Machining and Micro Milling
4. Understand Abrasive Jet Micro Machining and Micromachining with Abrasive Water jets
5. Explain the Ultrasonic Micromachining and its process capabilities
6. Appreciate the importance of Micro-electric Discharge Micromachining, Laser Micromachining Techniques, micromachining system, Focused Ion Beam Machining, Electro-chemical Spark Micro-Machining, Electron Beam Micromachining

Module 1
Introduction to Micromachining Processes: Introduction, Classification, Micromachining, Mechanical Advanced Micromachining Processes, Ultrasonic micromachining, Thermal advanced micromachining processes, electro discharge micromachining, Electron Beam machining, laser beam machining, electrochemical micromachining. 8 Hrs

SLE: Advanced Nano Finishing Processes

Module 2
Molecular Dynamics (MD) Simulations of Machining at the Atomistic Scale: Introduction, virtual/computer experiments, principles of MD simulations, potential energy functions, boundary conditions, MD simulation procedure.
Examples of MD simulations of nanometric cutting: Nanometric cutting of copper with a hard (tungsten) tool using Morse potentials, Nanometric cutting of silicon, Monte Carlo simulations at conventional cutting speeds, MD simulations of milling, Polishing of silicon wafer at the atomic scale, graphitization of diamond in the machining of iron. 08 Hrs

SLE: Mechanics of oblique machining

Module 3
Diamond Turn Machining: Material removal mechanisms in diamond turn machining.
Micro Milling: Introduction, micro milling mechanism and methods, applications of micro milling 08 Hrs

SLE: Micro milling machine
Module 4  
**Abrasive Jet Micro Machining:** Abrasive jet micromachining system, masking technology  
**Micromachining with Abrasive Waterjets (MAWs):** Introduction, generation of abrasive Waterjets, Abrasive water jet characteristics  
08 Hrs  
**SLE: Comparison between mask materials**  

Module 5  
**Ultrasonic Micromachining:** Introduction, Difference between USM and USMM, basic principles, machine tool, basic elements of USMM, mechanism of material removal in USMM, process parameters in USMM, performance characteristics and their evaluation, effect of process parameters on quality characteristics.  
08 Hrs  
**SLE: Process capabilities**  

Module 6  
Micro-electric Discharge Micro machining, role of EDM in micromachining, principle of micro EDM, Laser Micromachining Techniques and their Applications, lasers used for micromachining, laser beam characteristics, laser material interaction, laser micromachining system, Focused Ion Beam Machining, FIB equipment, imaging with FIB system, interaction of ion with substrate, terminologies related to ion and ion beam machining, Electro-chemical Spark Micro-Machining, mechanics of machining in ECSMM, mechanism of electro-chemical discharge phenomena, mechanism of material removal, Electron Beam Micro machining, mechanism of material removal in electron beam drilling, process parameters.  
12 Hrs  
**SLE: Electrochemical micro machining overview and importance**  

References:  
JOINING OF MATERIALS (4:0:0)

Course Code : MPT2C07
Hrs/Week : 04
SEE Hrs : 03

CIE : 50% Marks
SEE : 50% Marks
Max. Marks : 100

Course Outcome:

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

1. Explain the importance of grain size control, methods to avoid distortion and residual stresses; also know the techniques of surfacing and cladding of surfaces.
2. Interpret and understand the advantages and limitations of different advanced welding processes knowing fully the characteristic features, this identify research topics in the area of welding and related processes.
3. Explain the weld ability of engineering materials including plastics and the advanced soldering and brazing processes.
4. Design welds subjected to for various loading conditions.
5. Explain the symbols used to represent the welds: also be able to explain the methods of adhesive bonding of materials.
6. Inspect the welds in accordance with ASTM standards employing both destructive and non-destructive methods.

Module 1

Thermal Effects of Welding: Grain size Control, Micro structure control, Internal Stresses, control, Distortion, methods to avoid distortion. Stresses in Joint Design.

Welding and Cladding of Dissimilar Materials: Overlaying and surfacing, different methods and applications, thermal – Spray coating or metalizing.

SLE: Determining Stress Distribution.

Module 2


SLE: Thermit Welding.

Module 3

Weld ability of Metals : Stainless steel, Cast iron, Copper, and Aluminium.
Advanced soldering and brazing processes-different types. Welding of plastics- different methods

SLE: Weldability of Magnesium and Titanium Alloys.
Module 4

**Welding design:** Principles of sound welding design, welding joint design, welding positions, Allowable strength of welds under steady loads, allowable fatigue strength of welds, Design of welds subjected to combined stresses, Numerical examples  

**SLE: Weldment Design Program.**

Module 5

**Welding Symbols:** Need for representing the welds, Basic weld symbols, location of weld, supplementary symbols, dimensions of weld, examples.  
**Adhesive Bonding:** Adhesive materials and properties, non-structural and special adhesives, surface preparation and joint design considerations.  

**SLE: Process Capabilities.**

Module 6

**Inspection of Welds:** ASTM standards for testing weldments, Destructive techniques like Tensile, Bend, Nick break, Impact and Hardness. Non Destructive techniques like ‘X’ rays, Ultrasonic, Magnetic particle, Dye penetrant  

**SLE: Gamma ray Inspection.**

References:

ELECTIVE III

JIT AND LEAN MANUFACTURING (3:0:0)

Course Code: MPT2E301
Hrs/Week : 03
SEE Hrs : 03

CIE : 50% Marks
SEE : 50% Marks
Max. Marks : 100

Course Outcomes

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

1. Summarize CPC and JIT concepts.
2. Assess JIT production as an effective tool.
3. Choose an appropriate sequence and scheduling for effect parts and product delivery.
4. Analyze the lean tools such as 5S, techniques such as JIT, Kanban and Value Stream Mapping and explain the procedures for reducing setup time
5. Explain importance of Jidoka and worker involvement in production and understand the importance of global enterprise and analyze the lean manufacturing concepts adopted in industries.

Module 1:
Introduction: The mass production - origin of lean production system, system and system thinking, basic image of lean production, customer focus and muda.
JIT: Principle of JIT, JIT system, Kanban, e-Kanban, Kanban rules and expanded role of convenience, production levelling, pull system, Value stream mapping

SLE: Benefits of JIT.

08Hrs

Module 2:
Just in Time Production: Primary purpose, profit through cost reduction, Elimination of over production, Quality control, Quality assurance, Respect for humanity, Flexible work force, Adapting to changing production quantities, Process layout for shortened lead Times, Standardization of operation.

SLE: JIT Production

08 Hrs

Module 3:
Toyota Production System: The philosophy of TPS, Basic frame work of TPS, Kanban. Supplier Kanban and the Sequence schedule for Use by Suppliers - Later replenishment System by Kanban, sequenced withdrawal system, Circulation of the supplier Kanban within Toyota. Production smoothing in TPS, Production planning, Adaptability to demand fluctuations, Sequencing method for the mixed model assembly line to realize smoothed production of goal

SLE: Problems and counter measures in applying the Kanban system to sub contractors.

08Hrs
Module 4

**Stability and Standardization of Operations:** Standards in the lean system – 5S system – Total Productive Maintenance – standardized work – elements of standardized work – charts to define standardized work – man power reduction – Overall Equipment Efficiency - standardized work and kaizen.

**Shortening of Production Lead Times:** reduction of setup times, practical procedures for reducing setup time

*SLE: Multi-function workers and job rotation.*

Module 5

**Jidoka concept** – Poka-yoke systems; inspection systems and zone control; types and use of poka-yoke systems; Implementation of jidoka.

**Worker Involvement:** Involvement – activities to support involvement – quality circle activity – kaizen training.

**Managing Lean Enterprise:** Global enterprises and their benefits

*SLE: Lean concept in service sector.*

References:

2. Mike Rother and John Shook, Learning to See: Value Stream Mapping to Add Value and Eliminate MUDA, Lean Enterprise Institute, 1999.
3. Toyota Production System – An integrated approach to just in time by Yasuhiro Monden – Engineering and Management press – Institute of Industrial Engineers Norcross Georgia.
FLEXIBLE MANUFACTURING SYSTEMS (3:0:0)

Sub Code : MPT2E302  
Hrs/Week : 03  
SEE Hrs : 03  
CIE : 50% Marks  
SEE : 50% Marks  
Max. Marks : 100

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

1. Recall the concepts of FMS
2. Assess the use of data processing in FMS.
3. Identify the equipments for use in FMS.
4. Classify the FMS’s.
5. Utilize appropriate material handling equipment in FMS and Interpret the use of computing technology in FMS.

Module 1
Introduction to FMS - Concepts, Advantages, Components and examples of FMS, Distributed Numerical Control (DNC) - Communication between DNC computers  
SLE: MCU  
07 Hrs

Module 2
Distributed data processing in FMS - Computer network protocols - Interfacing of CAD and CAM - Part programming in FMS tool data base - Clamping devices  
SLE: Fixtures data base.  
07 Hrs

Module 3
SLE: Tool commissioning/setting area.  
08Hrs

Module 4
Types of FMS: Sequential FMS, Random FMS, Dedicated FMS, Modular FMS.  
FMS layouts: progressive layout, closed loop layout, Ladder layout, Open field layout. Applications of FMS: Metal-cutting machining, Metal forming, Assembly, Joining-welding (arc, spot), gluing.  
SLE: Surface treatment, Inspection, Testing.  
10 Hrs
Module 5
Material Handling Systems - ASRS - AGVs - Features of industrial robots - Robot cell design and control
Inspection: CMM – In cycle gauging - Sensors for robots.
Interfacing of computer - Machine tool controllers and handling systems: Communications standards, Programmable Logic Controllers (PLC’s) - Interfacing, Computer aided Project planning
SLE: FMS controls.

References:

4) Nanua Singh-Computer aided design/Manufacturing.
PRODUCT LIFECYCLE MANAGEMENT (3:0:0)

Sub Code : MPT2E303
Hrs/Week : 03
SEE Hrs : 03

CIE : 50% Marks
SEE : 50% Marks
Max. Marks : 100

Course Outcomes:
Upon successful completion of this course, the students will be able to:
1. Discuss the importance of collaborative product development and benefits of concurrent engineering.
2. Identify various CE techniques.
3. Use Information Technology in the lifecycle of a product.
4. Explain the various aspects of design stage of a product.
5. Discuss the importance of PLM and its applications for a problem solving in an industry and examine the various components of PLM and be able to practice its methodologies.

Module 1
Introduction: Extensive definition of Concurrent Engineering (CE), CE design methodologies, Components of CE, Review of CE techniques like DFM (Design for manufacture), DFA (Design for assembly), QFD (Quality function deployment), RP (Rapid prototyping), TD (Total design), for integrating these technologies, Organizing for CE, CE tool box, Benefits of Concurrent Engineering. 10 Hrs

SLE: Collaborative product development.

Module 2
Survey of CE techniques: Japanese Success, European Environment and CE in US Automotive industries. 06 Hrs

SLE: Case studies related to US automotive industries

Module 3
Use of Information Technology: IT supports, Solid modelling, Product data management, collaborative product commerce, expert systems, software hardware component design. 8Hrs

SLE: Artificial Intelligence

Module 4
Design Stage: Lifecycle design of products, Opportunities for manufacturing enterprises, Modality of concurrent engineering design, automated analysis idealization control, CE in optimal structural design. 08 Hrs

SLE: Real time constraints
Module 5

Need For PLM: Importance of PLM, Implementing PLM, and Responsibility for PLM, and Benefits to different managers, Components of PLM, Emergence of PLM and opportunities to seize.

Components of PLM: Components of PLM, Product lifecycle activities, Product organizational structure, Human resources in product lifecycle, Methods, Techniques, Practices, Methodologies, Processes, System components in lifecycle, Interfaces, Information, Standards.

SLE: Slicing and dicing the systems.

10 Hrs

References:

1. Integrated Product Development M.M. Anderson and L Hein IFS Publications.
5. Product Lifecycle Management John Stark Springer-Verlag, UK.
QUANTITATIVE TECHNIQUES IN DECISION MAKING (3:0:0)

Sub Code : MPT2E304
Hrs/Week : 03
SEE Hrs : 03
CIE : 50% Marks
SEE : 50% Marks
Max. Marks : 100

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

1. Identify the suitable statistical tool for decision making.
2. Explain the variations of distribution of data using different statistical models.
3. Distinguish the variations of distribution of statistical data.
4. Draw good decision in real time situation using assignment and transportation technique.
5. Explain the purpose and function of statistical quality control and to design new simple models, like: CPM, PERT to improve decision-making and develop critical thinking and objective analysis of decision problems.

Module 1:
Presentation and Analysis of Statistical Data: Tables and graphs as data presentation devices, Histogram and cumulative frequency curves.

SLE: Frequency Distribution.

Module 2:
Decision making under Uncertainty: Alternative criteria for decision under uncertainty.

SLE: Bayesian approach and Incremental analysis.

Module 3:
Correlation, Regression and Multivariate Analysis: Bi-variate frequency distribution and scatter diagram, Correlation analysis and Regression analysis, Non linear regression, auto correlation and multiple regression analysis, Multivariate analysis.

SLE: Solution of L.P.P. by dual simplex method.
Module 4:
Transportation and Assignment Problems: Structure of transportation problem and various methods of find I.B.F.S., Optimality test of transportation problems, Assignment problems and solution by Hungarian method
Theory of Games: Two person zero sum game, Minimax and maximin strategies, Solution of game by dominance rules, arithmetic and algebraic methods, Solution of game by graphical method and method of matrices, Solution of game by Linear programming approach and approximate and algebraic methods to solve game problems. 08 Hrs

SLE: Travelling Salesman Problem.

Module 5:
Network Analysis: PERT and CPM, Network construction and determination of critical path, Calculation of ES, EF, LS, LF, TF, FF and IF, Crashing of a project.
Waiting Line: Basic structure of queuing systems and characteristics, Expressions for M/M/1 queuing model.
Simulation of Management systems: Simulation and Monte Carlo method, Waiting line. 08 Hrs

SLE: Scheduling of a project.

References:
ELECTIVE IV

MODELING AND SIMULATION OF MANUFACTURING SYSTEMS
(3:0:0)

Course Code : MPT2E402
Hrs/Week : 03
SEE Hrs : 03

CIE : 50% Marks
SEE : 50% Marks
Max. Marks : 100

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

1. Interpret the fundamentals of computer modeling and simulation using various methods.
2. Introduce to the different technologies based on the system and model for solving simulation problems.
3. Elaborate various statistical models used for simulations.
4. Solve random variable problems using statistical distributions.
5. Interpret discrete data using statistical distribution and understand various simulation experiments and verification techniques.

Module 1

SLE: Areas of applications.

07 Hrs

Module 2
System and Environment: Components of a system, discrete and continuous systems, Models of a system - a variety of modeling approaches.


SLE: Single Channel Queue.

10 Hrs

Module 3:
Statistical Models in Simulation: Discrete distributions, Continuous distributions.

Random Number Generation: Techniques for generating random numbers, mid square method -the mod product method, Constant multiplier technique. Additive congruential method -Linear congruential method -Tests for random numbers -The Kolmogorov-Smirnov test, Ulfaskluna and Annita borsen Dohlgvist Publisher Artechhouse.

SLE: Chi-square Test.

12Hrs
Module 4:
**Random Variable Generation:** Inversion transforms technique, exponential distribution. Uniform distribution, Weibull distribution, continuous distribution, generating approximate normal variates

*8 Hrs*

**SLE:** Erlang Distribution.

Module 5:
**Empirical Discrete Distribution:** Discrete uniform -distribution Poisson distribution - geometric distribution - acceptance - rejection technique for Poisson distribution.

**Design and Evaluation of Simulation Experiments:** variance reduction techniques - antithetic variables, variables-verification.

**Simulation Software:** Selection of simulation software, simulation packages. 

*8 Hrs*

**SLE:** Gamma Distribution.

References:

NON DESTRUCTIVE TESTING (3:0:0)

Course code : MPT2E403  
CIE : 50% Marks  
Hrs/Week : 03  
SEE : 50% Marks  
SEE Hrs : 03  
Max. Marks : 100

Course Outcomes:
Upon successful completion of this course the student will be able to:

1. Know the basic concepts of NDT.
2. Detect discontinuities using magnetic particle inspection techniques.
3. Use the principles of eddy current inspection for the detection of discontinuities.
4. Learn the concepts of ultrasonic inspection by different methods for the detection of defects.
5. Evaluate the defects using radiography and its techniques and understand the concepts of optical holography for the detection of defects by using different methods.

Module 1
Introduction to ND Testing: Selection of ND methods, Leak testing, liquid penetration inspection, Advantages and limitation. 
08Hrs

SLE: Visual Inspection.

Module 2
Magnetic Particle Inspection: Methods of generating magnetic field, Types of magnetic particles and suspension liquids, steps in inspection.  
08Hrs

SLE: Application and limitations.

Module 3
Eddy Current inspection: Principles, Operation variables, procedure, Inspection coils and Detectable discontinuities. 
10Hrs

SLE: Microwave inspection: Microwave holography, Applications and Limitations

Module 4
Ultrasonic Inspection: Basic equipment, Characteristics of ultrasonic waves, Variables, Inspection methods - Pulse echo A,B,C scans transmission, Resonance techniques, Transducer elements couplants, search MODULEs, contact types and immersion types inspection standards 
10 Hrs

SLE: Standard Reference Blocks
Module 5:


**Optical Holography:** Basics of Holography, recording and reconstruction - Acoustical Holography: systems and techniques applications. **06 Hrs**

**SLE: Indian standards for NDT**

References:

PRINCIPLES OF RELIABILITY ENGINEERING (3:0:0)

Course Code : MPT2E404
Hrs/Week : 03
SEE Hrs : 03
Max. Marks : 100

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

1. Explain reliability management concepts.
2. Recommended various reliability models and their applications.
3. Predict design systems and processes for reliability.
4. Demonstrate the failure data and modeling.
5. Predict various tools available in reliability engineering to model and predict reliability.

Module 1


Component life models: (Basic Reliability Models)

Failure distribution: The reliability function, mean time to failure, hazard rate function, hazard rate function, bathtub curve, conditional reliability

Constant failure rate model: The exponential reliability function, Failure modes, applications, the two Parameter Exponential distribution, Poisson process, redundancy and CFR model exercises 08 Hrs

SLE: Organizations involved in reliability work.

Module 2
Reliability Prediction and Modelling: Reliability of Systems, Serial Configuration, Parallel Configuration, Combined Series-Parallel system, Block Diagram analysis, States Dependent systems, System structure function, Minimal cuts and Minimal paths. Common mode failure, Three state devices, State space analysis (Markov analysis), Load sharing systems, Standby systems, B Graded systems, Reliability Apportionment, Fundamental Limitations of Reliability Prediction, Reliability Databases, Modular Design. 08 Hrs

SLE: Fault Tree Analysis (FTA), Petri nets.
Module 3


SLE: Reliability Growth Monitoring.

Module 4

Design for reliability: Computer Aided Engineering (CAE), Environment, Reliability specification and systems measurement, Reliability allocation, Design methods, Failure analysis, Load strength analysis (LSA), Failure modes, Effects and critical analysis, Hazard and operability study (HAZOPS), Human reliability, Design analysis for processes, Critical Item list, Management of Design review, Parts Materials and Process (PMP) Review.


SLE: Software structure and modularity, Data reliability, Software checking, Software design analysis methods.

Module 5


SLE: Inspection and Repair Availability Model, Design Trade-off Analysis.

Reference Books:
OPERATIONS RESEARCH (3:0:0)

Course Code : MPT2E405  
Hrs/Week : 03  
SEE Hrs : 03  

CIE : 50% Marks  
SEE : 50% Marks  
Max. Marks : 100  

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

1. Understand the mathematical tools that are needed to solve optimization problems.
2. Explain clearly basic concepts of linear and integer programming.
3. Solve a practical problem multi-stage recourse problems
4. Solve problems under uncertain conditions using simulation models.
5. Formulate real-life applications in terms of appropriate Markov chain.
   stochastic models of operations research and formulation of the most economic replacement policy which is in the interest of the system.

Module 1
**Basics of Operations Research:** Origin, art of modelling, phases of OR, applications.

**Linear Programming:** Formulation, graphical solution, simplex method, duality, dual simplex method. Assignment model, Transportation model

**Integer Programming:** Definition, classification, Gomory’s cutting plane method.

**SLE:** Degeneracy Problem, Multiple Solution Problems  
12Hrs

Module 2
**Dynamic Programming:** Introduction features and characteristics, recursive equation, Bellman’s principle, minimum path problem, cargo loading problem, reliability problem.

**SLE:** Capital Budgeting Problem.

08Hrs

Module 3
**Markov Analysis:** Markov process, state transition matrix, tree diagram, steady state condition, Markov analysis algorithm.

**Waiting line model:** Introduction, terminology, Queuing system, queuing models.

**SLE:** Birth and Death Process Derivations.

08Hrs

Module 4
**Simulation:** Introduction, uses of simulation, simulation terminology, Monte-Carlo simulation, generation of random numbers, typical problems.

**SLE:** Simulation Languages.

06Hrs
Module 5

Replacement Model: Introduction, replacement policies for item that deteriorate without change in money value, with change in money value, items that fail completely, group replacement.

SLE: Staffing Problems.

References

MANUFACTURING SYSTEM LABORATORY-II (0:0:2)

Course Code : MPT2L01
Hrs/Week 02

CIE : 50% Marks
SEE : 50% Marks
Max.Marks : 50

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

1. Build up hydraulic and pneumatic circuits
2. Fabricate composites by various techniques

Lab -1

1. Building up of hydraulic pressure intensification circuit
2. Building up of hydraulic regenerative cylinder.
3. Comparison of tandem centre and closed centre directional control valve.
6. Exercises on will, travel and time dependent control in pneumatic systems.
7. Building up of AND & OR logic functions in pneumatic system.
8. Exercises on cascading circuits for sequential motion of cylinders.

Lab -2:

1. To fabricate polymer composites with hand lay-up technique
2. To characterize the fabricated composites for mechanical and tribological properties
Industry Driven Elective

PROJECT MANAGEMENT 2:0:0)

Sub Code : MPT2I01  CIE : 50% Marks
Hrs/Week : 02  SEE : 50% Marks
SEE Hrs : 02  Max. Marks : 50

Course Outcomes:
Upon successful completion of this course, the students will be able to:
1. Describe Concepts of Project Management and Prepare feasibility reports, cost estimations and evaluations of projects
2. Demonstrate the skills, responsibilities of project manager including project organization and accountability and explain the principles of project scheduling tools and technique of project management
3. Demonstrate coordination and control Performance Measures in Project Management and utilize the tools and techniques used for performance evaluation in project management

Module 1
Concepts of Project Management: Concepts of a project, Categories of projects, Phases of project life cycle, Tools and techniques for project management,


SLE: Roles and responsibility of project leader

Module 2
Organizing and Staffing the Project Team
Project Charter, Stakeholder management, Project organization and types, accountability in project execution, controls, Contracts, 3 Rs of Contracting, Human Resources Management in Projects

Project Scope, time and cost management
Scope - Scope definition, Work Breakdown Structure, Scope verification, Scope Control; Time – Activity definition, sequencing, Cost – Estimating, Budgeting, controlling 09Hrs

SLE: Authorities and responsibilities of project manager

Module 3
Project Execution and Control: Project Performance analysis – Earned value technique Schedule control and Progress reporting
Risk and Quality Management: Risk management plan, Risk categories, Probability and impact, Risk response planning
Ethics and Professional Standards in Project Management  10 Hrs

SLE – Role of MIS in project control, performance control, schedule control and cost control

Reference Books:

1. “Project Management Handbook”, Uddesh Kohli, K KChitkara, TMH
2. “Project”, Prasanna Chandra, TMH
MOOC ELECTIVE (12 WEEKS) MANAGEMENT DEPARTMENT

Open Elective – (MOOC) (8 weeks)

Both the course will be decided based on the availability of the course in MOOC during that particular academic year.
INDUSTRIAL TRAINING

Sub Code: MPT3C02  Evaluation in the Dept  : 50% Marks
Duration: 8 Weeks  Evaluation in the Industry  : 50% Marks
                       Max. Marks    : 50

Course Outcomes:

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

1. Understand complex production engineering problems faced by the industry
2. Know appropriate modern tools for the solution of the same.
3. Understand group dynamics and the need for working in a multidisciplinary team.
4. Communicate effectively, both oral and written.

The students have to undergo training individually in a reputed industry for eight weeks duration.

At the end of the training, students are required to submit a report and give a presentation on the same.

PROJECT WORK - PHASE -I

Sub Code: MPT3C03  Mid-Term Evaluation : 50% Marks
Duration : 8 Weeks  Final Evaluation : 50% Marks
                       Max. Marks    : 100

Course Outcomes:

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

1. Identify the problem and carry out literature survey so as to comprehend the same.
2. Formulate the problem by defining its objectives and scope.
3. Decide the appropriate modern tools to be used for solving complex engineering problem
4. Initiate the project by conducting experiments, interpreting and analyzing data.
5. Write reports and make effective presentations.

The students have to identify and initiate the project.
• The students have to individually identify and initiate the project at reputed industries / R and D Institutions / Department research center.
• Define the problem based on literature survey mentioning the objectives and scope.
• Arrive at the methodology for carrying out the project.
• A report has to be submitted and a presentation to be made.
SEMINAR

Sub Code: MPT3C04  Max. Marks: 50

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

1. Extract pertinent information on the topic to be presented through literature survey.
2. Comprehend and critically analyze the topic.
3. Make effective presentation of the topic and write reports.

- The students individually have to select a current research topic in production engineering field by referring to literature.
- A report has to be submitted and also a seminar to be presented.

OPEN ELECTIVE FOR OTHER PG PROGRAMS
LEAN PRACTICES (3:0:0)

Course Code : MPT3O01  CIE : 50% Marks
Hrs/Week : 03  SEE : 50% Marks
SEE Hrs : 03  Max. Marks : 100

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

1. Recognize the underlying philosophy of the Toyota Production System.
2. Analyze the different concepts of stabilizing the operations with the help of lean tools.
3. Recall the concepts Standardization of operations and JIT principles.
4. Understand the importance of lead time reduction with the help of lean tools and Lean six sigma
5. Understand the continuous improvement concept and explain how to manage people in a Lean environment in order to sustain improvements in production method.

Module 1
Introduction: Mass production system, origin of lean production system, necessity, lean revolution in Toyota, systems and systems thinking, basic image of lean production, customer focus. 8Hrs

SLE: Muda (waste)
Module 2
Stability of lean system: Standards in the lean system, total productive maintenance, standardized work, elements of standardized work, charts to define standardized work, man power reduction, overall efficiency - standardized work and kaizen, common layouts.

Lean tools: 5S system, why-why analysis, Ishikawa diagram.

SLE: Case study on lean tool implementation. 8Hrs

Module 3
Standardization of operations: job rotation, Improvement activities to reduce work force and increase worker morale foundation for improvements.

Just In Time: Principles of JIT, JIT system, Kanban, Kanban rules, expanded role of conveyance, production levelling, pull systems, value stream mapping.

SLE: Multi-function workers. 8Hrs

Module 4
Shortening of production lead times: Reduction of setup times: practical procedures for reducing setup time, Jidoka concept, poka-yoke (mistake proofing) systems, inspection systems and zone control, types and use of poka-yoke systems.

Lean Six Sigma: Process, Quality control, quality assurance, reliability, PDCA concepts

SLE: Implementation of Jidoka. 10Hrs

Module 5
Worker Involvement and Systematic Planning Methodology: Involvement, activities to support involvement, quality circle activity, Kaizen training, suggestion programmes, Hoshin planning system (systematic planning methodology), phases of Hoshin planning.

Managing lean enterprise: Global enterprises and their benefits.

SLE: Lean culture. Application of Lean practices in enterprises and service sector

Text books
References:

IV SEMESTER

PROJECT WORK - PHASE-II

Sub Code : MPT4C01
Duration : 16 Weeks
Max. Marks : 100

Mid-Term Evaluation : 50% Marks
Final Evaluation : 50% Marks

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

1. Comprehend the problem in-depth.
2. Understand group dynamics and need for working in groups and able to contribute in multidisciplinary environment.
3. Analyze, evaluate, synthesize and apply learning’s to the problem.
4. Make use of appropriate modern engineering tools and techniques to arrive at feasible solution, considering the financial implications.
5. Make effective presentations and write comprehensive reports and transact with engineering community.
6. Acquire professional and intellectual integrity, ethics and social responsibility, and understand the need for lifelong learning.

The students have to arrive at optimal / feasible solutions for problems on production systems considering ergonomics, safety, social, and environmental aspects.

- The students have to continue the project work initiated in the third semester.
- A mid-term evaluation is conducted to review the progress and the students have to submit a report and present the same.
- At the conclusion of the project, the students have to submit a final report.
- Final report will be evaluated by Board of Examiners and the students are required to defend their project work.
- Evaluation of project work shall include weightage of 10% of the marks for publication in Conferences and/or Journals.