M.Tech

Production Engineering and System Technology

(2020-22)

Scheme of Teaching and Examination

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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)

Sl. No.	Course Code	Course	Contact Hrs. / Week			No. of Credits
			L	T	P	
1	AMP1C01	Applied Mathematics	4	0	0	4
2	MPT1C04	Material Removal Processes	4	2	0	5
3	MPT1C02	Automated Manufacturing Systems	4	2	0	5
4	MPT1C03	Corporate Finance	4	0	0	4
5	MPT1E1XX	Elective – I	3	0	0	3
6	MPT1E2XX	Elective – II	3	0	0	3
7	MPT1CRM	Research Methodology	2	0	0	2
8	MPT1L01	Manufacturing system Laboratory-1	0	0	2	1
Total number of credits						**27**
Contact hours per week						**30**

Elective-I

Sl. No	Course Code	Course	Contact Hrs. / Week			No. of Credits
			L	T	P	
1	MPT1E101	Industrial Design and Ergonomics	3	0	0	3
2	MPT1E102	Robotics for Industrial Automation	3	0	0	3
3	MPT1E103	Design for Manufacturing	3	0	0	3
4	MPT1E105	Dimensional Metrology and Quality Engineering	2	0	2	3

Elective-II

Sl. No	Course Code	Course	Contact Hrs. / Week			No. of Credits
			L	T	P	
1	MPT1E201	Theory of Metal Forming	3	0	0	3
2	MPT1E202	Tool Design	3	0	0	3
3	MPT1E203	Additive Manufacturing	3	0	0	3
4	MPT1E204	Surface Treatment and Finishing	3	0	0	3

II Semester

Sl. No.	Subject Code	Course	Contact Hrs. / Week			No. of Credits
			L	T	P	
1	MPT2C02	Finite Element Analysis	4	2	0	5
2	MPT2C05	Fluid Power Automation	4	2	0	5
3	MPT2C06	Micro Machining-	4	0	0	4
4	MPT2C07	Joining of Materials	4	0	0	4
5	MPT2E3XX	Elective – III	3	0	0	3
6	MPT2E4XX	Elective – IV	3	0	0	3
7	MPT2I01	Industry Driven Elective	2	0	0	2
8	MPT2L01	Manufacturing system Laboratory-2	0	0	2	1
Total number of credits						**27**
Contact hours per week						**30**

Elective-III

Sl.No	Subject Code	Course	Contact Hrs. / Week			No. of Credits
			L	T	P	
1	MPT2E301	JIT and Lean Manufacturing	3	0	0	3
2	MPT2E302	Flexible Manufacturing Systems	3	0	0	3
3	MPT2E303	Product Lifecycle Management	3	0	0	3
4	MPT2E304	Quantitative Techniques in Decision Making	3	0	0	3

Elective-IV

Sl.No.	Course Code	Course	Contact Hrs. / Week			No. of Credits
			L	T	P	
1	MPT2E402	Modelling and Simulation of Manufacturing systems	3	0	0	3
2	MPT2E403	Non Destructive Testing	3	0	0	3
3	MPT2E404	Principles of Reliability Engineering	3	0	0	3
4	MPT2E405	Operations Research	3	0	0	3

III Semester

Sl. No.	Course Code	Subject	Contact Hrs. / Week			No. of Credits
			L	T	P	
1	MPT3MXX	MOOC Elective (12 weeks) Management Department	3	0	0	3
2	MPT3OXX	Open Elective – (MOOC) (8 weeks)	2	0	0	2
3	MPT3C02	Industrial Training/ Internship	-	-	-	5
4	MPT3C03	Project work-Phase-I	-	-	-	8
5	MPT3C04	Seminar	-	-	-	1
Total number of credits						**19**

IV SEMESTER

Sl. No.	Course Code	Subject	Contact Hrs. / Week			No. of Credits
			L	T	P	
1	MPT4C01	Project work -Phase-II	-		-	15
Total number of credits						**15**

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

Sub Code	**: APM1C01**	**CIE**	**: 50% Marks**
Hrs/Week	**: 04**	**SEE**	**: 50% Marks**
SEE Hrs	**: 03**	**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. Diogonalising 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 **9 Hrs**

SLE: Gauss elimination method.

Module 2

Linear Algebra - 2

Vectors & vector spaces, Linear Transformations - Kernel, Range Matrix of linear transformation Inverse linear transformation, Inner product, Length / Norm Orthogonality, orthogonal projections Orthonormal bases. Gram-Schmidt process **9 Hrs**

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.

8 Hrs

Module 4

Sampling Theory

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

SLE: Correlation and Regression.

9 Hrs

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.

8 Hrs

Module 6

Optimization

Standard form of LPP, Simplex method, Big-M method, Duality, Non-Linear programming problems

SLE: Degeneracy in simplex method

9Hrs

References :

1. **Linear Algebra** – Larson & Falvo (Cengage learning)
2. **Higher Engineering Mathematics** – Dr. B.V. Ramana, 5th edition, Tata McGraw – Hill publications.
3. **Higher Engineering Mathematics** – Dr. B.S. Grewal, 42nd edition, Khanna publication.
4. **Probability and Statistics** – Schaum Series **(**All latest editions**)**
5. **Probability, Statistics and Random Processes**, T Veerarajan-3rd Edition,Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008.

MATERIAL REMOVAL PROCESSES (4:2:0)

Sub Code : MPT1C04	**CIE : 50% Marks**
Hrs/Week : 06	**SEE: 50% Marks**
SEE Hrs : 03	**Max. Marks : 100**

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.

08 Hrs.

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. **06 Hrs.**

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. **06 Hrs.**

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. **10 Hrs.**

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

References:

1. Fundamentals of Metal Machining and Machine Tools by Geoffrey Boothroyd, Tata McGraw-Hill Publication 3rd edition 2006,

2. Metal Cutting Principles by M.C.Shaw, Oxford Publication, 2005.

3. ASM Handbook, Vol.16, Machining, Fifth printing, December 2009.

4. Machining of Hard Materials, J Paulo Davim, Springer publications

5. Fundamentals of Metal Cutting and Machine Tools by B.L. Juneja and G.S. Sekhon– New age publications, 2nd Edition, 2003.

6. New Technology by Bhattacharya, Institute of Engineers publications.

7. Modern Machining Process by P.C.Pandey and H.S.Shan, Tata McGraw-Hill Publication, 2004.

AUTOMATED MANUFACTURING SYSTEMS (4:2:0)

Sub Code	**: MPT1C02**	**CIE**	**: 50% Marks**
Hrs/Week	**: 06**	**SEE**	**: 50% Marks**
SEE Hrs	**: 03**	**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.
Industrial Control Systems: Process industries versus discrete manufacturing industries, Continuous control systems, Adaptive control, On-line search strategies, Discrete control systems, Computer Process Control, Direct digital Control, Programmable logic controllers, Supervisory control. **09 Hrs**

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:

Manual Assembly Lines: Fundamentals of manual assembly lines, Analysis of single model assembly lines, The line balancing algorithms, Largest Candidate rule, Kilbridge and Wester method, Ranked Positional Weights method, Mixed model assembly lines - Mixed model line balancing. **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:

1. Automation Production Systems and Computer Integrated Manufacturing, Mikell P. Groover, 4th Edition, Pearson Publication, 2016.
2. CAD/CAM/CIM – P. Radhakrishna, New Age International, 2nd edition, 2000.
3. CAD/CAM – Zeid, Mc-Graw Hill.2005.
4. CAD/CAM,- P.N.Rao.TMH 2nd edition-2004.
5. “Artificial Intelligence” -By Elaine Rich And Kevin Knight (2nd Edition) Tata Mcgraw-Hill

CORPORATE FINANCE (4:0:0)

Course Code: MPT1C03 **CIE : 50% Marks**
Hrs/Week : 04 **SEE : 50% Marks**
SEE Hrs : 03 **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. **8Hrs**

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. **10 Hrs**

SLE: Dividend policies in practice.

Text Books:

1. **Financial management** –I M Pandey, Vikas publishing House Pvt. Ltd.,11th edition, 2015.
2. **Financial Management** – **Theory and practice**, Prasanna Chandra, 9th edition, 2015. Tata McGraw Hill publishing company ltd.,

References:

1. **Financial Management and Policy** – James C.Van Horne & Sanjay Dhamija, Pearson, 12th Edition.
2. **Fundamentals of Financial Management** - James C. Van Horne & John.M. Wachowicz, Jt.,13th Edition.
3. **Financial Management Text, Problems and Cases** – Khan and Jain, 7th edition, 2015- Tata McGraw Hill publishing company ltd.,
4. Principles of Corporate Finance, Richard A Brealy and Steward C Myers, 11th Edition, McGraw Hill

RESEARCH METHODOLOGY (2:0:0)

Course Code : MPT1CRM **CIE : 50% Marks**
Hrs/Week : 02 **SEE : 50% Marks**
SEE Hrs : 02 **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 **10Hrs**

SLE: Develop a scientific study for carrying out research

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.

Thesis Writing and Journal Publication: Writing thesis, writing journal and conference papers, IEEE and Harvard styles of referencing. Effective presentation, copy rights and avoiding plagiarism. **10 Hrs**

SLE: Novelty in writing high impact journal articles

Text Books :

1. C R Kothari "Research **Methodology**" New Age International second revised edition, 2014
2. Deepak Chawla, Neena Sandhi "**Research Methodology Concepts & Cases**" Vikas Publications, 2nd edition, 2011.

Reference Books:

1. Garg BL, Karadia, R Agarwal and Agarwal, **"An Introduction to Research Methodology,** RBSA Publishers 2002
2. Levine S.P and Martin, **Protecting Personnel at Hazardous Wastesites**, Butterworth,1985, Blake R.P., Industrial Safety, Prentice Hall, 1953.
3. Sinha S.C. and Dhiman AK, **"Research Methodology",** Ess, Ess Publications, 2002
4. Fink A, "**Conducting Research Literature Reviews: From the internet to paper, Sage Publications, 2009**
5. Donald R. Cooper and Pamela S. Schindler, (2013). Business Research Methods, TMH, New Delhi, 12th Edition.
6. John W. Creswell, (2003). Research Design, Qualitative, Quantitative and Mixed Approaches, 2ndEdition, Sage Publication.
7. William G. Zikmund, Jon C. Carr, Barry Babin, Mitch Griffin, (2013). Business Research Methods, Cengage Learning.

ELECTIVE I

INDUSTRIAL DESIGN AND ERGONOMICS (3:0:0)

Sub Code	**: MPT1E101**	**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. 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. **10 Hrs**

SLE: Local environment-light, Heat, Sound, Design of layouts.

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 **10 Hrs**

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 **08 Hrs**

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, Munsel colour notation, reactions to colour and colour combination – colour on engineering equipments, Colour coding, Psychological effects, colour and machine form, colour and style. **08 Hrs**

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. **06Hrs**

SLE: Golden ratio and use of aesthetics in design.

References Books:

1. Mayall W.H. "Industrial design for Engineers", London Hiffee books Ltd., 1988.
2. Brain Shakel (Edited), "Applied Ergonomics Hand Book", Butterworth scientific. London 1988.
3. Introduction to Ergonomics by R.C.Bridger, 2nd Edition, Re print 2017, McGraw Hill Publications.
4. Human factor Engineering and Design – Sanders and McCormick, McGraw Hill Publications, Reprint 2018.

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:

Navigation: Reactive Navigation, Battenberg Vehicles, Simple Automata, Map-Based Planning, Distance Transform, D*, Verona Roadmap Method, Probabilistic Roadmap Method, Localization, Dead Reckoning, Modelling the Vehicle, Estimating Pose, Using a Map, Creating a Map, Localization and Mapping, Monte-Carlo Localization. **9 Hrs**

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. **9 Hrs**

SLE: Joint Angle Offsets, Determining Denavit - Hartenberg Parameter

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.

Robot Programming : SCORBOT programming, IS-14533 : 2005 Manipulating industrial robots - Performance criteria related test methods, Mobile Robot Programming, Industrial Robot Programming. **9Hrs**

SLE: Saving and playing back data in ROS.

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:

1. Robotics, Vision and Control: Fundamental Algorithms in MATLAB® - Peter Corke, Springer Tracts in Advanced Robotics, Volume 73, 2011.
2. Learning ROS for Robotics Programming - Aaron Martinez & Enrique Fernández, Packt Publishing, September 2013
3. Robotics for Engineers -Yoram Koren, McGraw Hill International, 1st edition, 1985.
4. Industrial Robotics-Groover, Weiss, Nagel, McGraw Hill International, 2nd edition, 2012.
5. Robotics, control vision and intelligence-Fu, Lee and Gonzalez. McGraw Hill International, 2nd edition, 2007.
6. Introduction to Robotics- John J. Craig, Addison Wesley Publishing, 3rd edition, 2010.

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. **10 Hrs**

SLE: Material selection process, achieving larger machining tolerances.

Module 2

Datum Features: Functional datum**,** Datum for manufacturing**.** **08 Hrs**

SLE: Changing the datum.

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. **08 Hrs**

SLE: Castings requiring special sand cores.

Module 4

Component Design: Component design with machining considerations like design for turning components-milling, drilling and other related processes. **08 Hrs**

SLE: Finish-machining operations.

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:

1. Harry peck, "Design for Manufacture", pitman publications.
2. Dieter – "Machine Design", McGraw Hill publications.
3. R.K.Jain "Metrology", Khanna publications.
4. Geoffrey Boothroyd, peter dewhurst, Winston Knight, "Product Design for Manufacture and Assembly". Mercel dekker, Inc. Newyork.

DIMENSIONALMETROLOGY AND QUALITY ENGINEERING (2:0:2)

Sub Code	**: MPT1E105**	**CIE**	**: 50% Marks**
Hrs/Week	**: 04**	**SEE**	**: 50% Marks**
SEE Hrs	**: 03**	**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.
3. Recall the Coordinate Measuring Machine principle.
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 Manufacturing Engineering: Importance of manufacturing planning for quality, Initial planning for quality, Concept of controllability: Self controls, defining quality responsibilities on the factory flow, Self inspection, automated manufacturing, overall review of manufacturing planning, Process quality audits.

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. **08 Hrs**

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. **08 Hrs**

SLE: Six sigma - the 'DRIVE' framework for continuous improvement.

References:

1. Oakland J S, "Total Quality Management - Text with Cases", Butterworth – Heinemann – An Imprint of Elseiver, First Indian Print, 2005.
2. Nambiar K R, "Lasers – Principles, Types and Applications', New Age International Limited Publishers, 2004.
3. Dotson C, Harlow R and Thompson R, "Fundamentals of Dimensional Metrology", Thomson Delmer Learning, Singapore, 4th Edition, 2003.
4. John A Bosch, Giddings and Lewis Dayton, "Coordinate Measuring Machines and Systems", Marcel Dekker, Inc., 1999.
5. Juran J M and Gryna F M, "Quality Planning and Analysis", Tata McGraw Hill Edition, 1995.
6. Wilson J and Hawker J F B, "Lasers – Principles and Applications", Prentice Hall, 1987.

ELECTIVE II

THEORY OF METAL FORMING (3:0:0)

Sub Code	**: MPT1E201**	**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 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. **10Hr**

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.**8Hrs**

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:

Rolling of metals: Classification, Forces and geometrical relationships in rolling. Variables in rolling, Deformation in rolling, Roll pressure determination from local stress evaluation. Different types of roll mills. Defects in rolled products, Residual stresses in rolled products. **08 Hrs**

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

References :

1. Principles of Industrial Metal Working processes –Geoffrey W. Rowe- Arnold London-CBS publishers and distributors, 2005.
2. Mechanical Metallurgy- Dieter G.E- McGraw-Hill publication.
3. Metals Handbook-Volume II-ASME.
4. Fundamentals of Working of Metals by Sachy, Pergamon press.

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.
4. Design press working tools, sheet metal bending, forming and drawing dies.
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.

Tooling Materials and Heat Treatment: Introduction, Properties of materials, Ferrous tooling materials, Non-ferrous tooling materials, Non-metallic tooling materials, Heat treatment and tool design. **06 Hrs**

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.

Design of Tools for Inspection and Gauging: Introduction, Work piece quality criteria, Principles of gauging, Types of gages and their applications, Amplification and magnification of error, Gage Tolerances, Indicating gages, Automatic gages, Gauging positional tolerance parts, problems. **10 Hrs**

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:

1. Tool Design - Cyril Donaldson, GH Lecain and VC Goold - TMH Publishing Co Ltd., New Delhi, - 4theditions, 2012.
2. Fundamentals of Tool Design – ASTME - PHI (P) Ltd., New Delhi -1987.
3. "Tool Engineering and Design" G.R Nagpal, Khanna Publishers 6thEdition ,2009.

ADDITIVE MANUFACTURING (3:0:0)

Sub Code	**: MPT2E203**	**CIE**	**: 50 % Marks**
Hrs / Week	**: 03**	**SEE**	**: 50% Marks**
SEE Hrs	**: 3 Hrs**	**Max. Marks: 100**	

Course Outcomes:
Upon successful completion of this course, the student will beable 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**.** **6 Hrs**

Self Learning Exercise: classification of RP systems

Unit 2:

Stereo Lithography Systems: Principle, Process parameter, Process details, Data preparation, data files and machine details, Application
Selective Laser Sintering and Fusion Deposition Modeling : Type of machine, Principle of operation, process parameters, Datapreparation for SLS, Applications, process parameter, Path generation, Applications. **6Hrs**

Self Learning Exercise: Principle of Fusion deposition modeling

Unit 3:

Solid Ground Curing: Principle of operation, Machine details, Applications.
Laminated Object Manufacturing: Principle of operation, Process details, application.
7Hrs

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. **6 hrs**

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 castprocess, Copper polyamide, Rapid Tool, DMILS,Prometal, Sandcasting tooling. **7Hrs**

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

Unit 5:

RP Process Optimization: factors influencing accuracy. Datapreparation errors, Part building errors, selection of part build orientation. **7Hrs**

Self Learning Exercise: Error in finishing.

Text Books:

1. Pham D.T. & Dimov S.S "Rapid Manufacturing" Springer London 2011.

Reference Books:

1. Terry Wohlers "Wohler's Report 2000" Wohler's Association 2000.

2 Paul F. Jacobs: "Stereo lithography and other RP & M Technologies", SME, NY 1996, Springer

SURFACE TREATMENT AND FINISHING (3:0:0)

Course code	**: MPT1E204**	**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. 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

Fundamentals of Electroplating: Galvanizing, Hot dip metal coating, Tin coating, Chromium plating, Nickel plating.

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 Hardening, 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:

2. Surface Preparations and Finishes for metals, James A Murphy Mc.Graw Hill.
3. Principles of Metal surface treatment and protection, Pergamon press-Gabe, David Russell.
4. Handbook of metal treatment and testing-John Wileyand Sons.
5. Heat treatment of metals by Zakrov, MIR publications.
6. Metal handbook – ASM. 1993.
7. Integrated pollution Prevention and control, reference document on best available techniques for the "Surface treatment of metals and plastics" Aug 2006, European commission report.

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

Course Code : MPT1L01 **CIE : 50% Marks**
Hrs/Week : 02 **SEE : 50% Marks**
SEE Hrs : 03 **Max. Marks: 100**

Course Outcomes:

Upon successful completion of this course, the students will 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. Carryout 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 carryout 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 out puts after some specified delay
4. Implementing counter function in PLC
5. Accepting analog inputs fro 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. **07Hrs**

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. **11Hrs**

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. **10 Hrs**

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. **07Hrs**

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 **10Hrs**

SLE: classification and description of metal forming processes

Tutorial component:

1. Analysis of stresses in bar and truss for different load condition.
2. Analysis of beams and stress concentration problems.
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:

1. Introduction to Finite Elements in Engg., T.R. Chandrupatla, PhD, P E, Ashok. D. Belegundu, 4th edition 2011.
2. Fundamentals of Finite Elements Method, 2nd Edition, - Dr. S. M. Murigendrappa., International Publication- 2009.
3. A First Course in Finite Element Method, 3rd Edition Dory. L. Logan, University of Wisconsin, Platteville Thamson.
4. Finite Element Method, R.D. Cook, John Willy International, New edition.
5. Introduction to Finite Element Method, Chandrakantha S. Desai, John F.Abel East,
6. 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:

1. Fluid Power with application, 5th edition, Anthony Esposito, Pearson Education,2000.
2. Oil hydraulics -Principles and maintenance, S.R. Majumdar, Tata M C Graw Hill, 1st edition, 2001.
3. Pneumatic system, principles and maintenance, S.R. Majumdar, Tata M C Graw Hill publication, 2001.
4. Hydraulics Trainer- Vol 1, Components and application, Rexroth - Bosch Publication.
5. Pneumatics: Theory and applications, Rexroth - Bosch Publication.
6. Electro Pneumatics Vol. 2, Rexroth - Bosch group 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, principlesof 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:

1. Introduction To Micromachining , V.K.Jain , Second Edition, Narosa Publishers, New Delhi,2014.
2. Micro manufacturing Processes By V. K. Jain (Editor), CRC Press. 2014
3. Micromachining of Engineering Materials By J.A. Mc Geough, CRC Press, 2001.
4. Mark J. Jackson, Micro and Nano fabrication, CRC Press, Taylor & Francis Group, 2010.

JOINING OF MATERIALS (4:0:0)

Course Code : MPT2C07	**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. 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 process 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. **08 Hrs**

SLE: Determining Stress Distribution.

Module 2

Types of Welding : Solid state weldig, Forge welding, Electro Slag Welding, Electron Beam Welding, Plasma arc Welding, Laser Beam Welding, Explosion Welding, Diffusion Welding, Ultrasonic Welding, Friction welding. **12 Hrs**

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 **10Hrs**

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 **08 Hrs**

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**.** **06 Hrs**

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

08Hrs

SLE: Gamma ray Inspection.

References:

1. Welding Engineering Handbook by A.W.S. Ninth Edition.
2. Advanced Welding processes – G.Nikolaev and N.Olshansky, MIR Publications 1977.
3. Welding Technology by O.P. Khanna, Dhanpat Rai Publication 2015.
4. Welding and welding Technology by Richard Little Tata Mc Graw hill 2005.
5. ASM handbook on welding, brazing and soldering, Vol 6, 2013.
6. Advanced welding Technology by Dr. K S Yadav, Standard book house 2017.

ELECTIVE III

JIT AND LEAN MANUFACTURING (3:0:0)

Course Code: MPT2E301	**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. 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

08Hrs

SLE: Benefits of JIT.

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. **08 Hrs**

SLE: JIT Production

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 **08Hrs**

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

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 **08 Hrs**

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 **10Hrs**

SLE: Lean concept in service sector.

References:

1. Pascal Dennis, Lean Production Simplified: A Plain- Language Guide to the World's Most Powerful Production System, (Second edition), Productivity Press, New York, 2007.
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 aild Management press – Institute of Industrial Engineers Norcross Georgia.
4. Amaldo Hernandez: "Just in Time Manufacturing" PH International, 2014.
5. "The Machine that changed the World" by Daniel Roos, 2014.

FLEXIBLE MANUFACTURING SYSTEMS (3:0:0)

Sub Code	**: MPT2E302**	**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. 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

07 Hrs

SLE: MCU

Module 2

Distributed data processing in FMS - Computer network protocols - Interfacing of CAD and CAM - Part programming in FMS tool data base - Clamping devices

07 Hrs

SLE: Fixtures data base.

Module 3

Equipment in FMS: Primary equipment, Work centers, Universal machining centers (prismatic FMSs) Turning centers (rotational FMSs), Grinding machines, Nibbling machines. Process centers: Wash machines, Robotic workstations, Manual workstations. Secondary equipment: Support stations, Pallet/fixture/ load/unload stations

08Hrs

SLE: Tool commissioning/setting area.

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. **10 Hrs**

SLE: Surface treatment, Inspection, Testing.

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 **10 Hrs.**

SLE: FMS controls.

References:

1) Mikell P Groover, "Automation Production systems, Computer Integrated Manufacturing", Prentice Hall, 2008.
2) Paul Ranky., "The design and operation of FMS", IFS publication., 1983.
3) Viswanathan, N and Nahari, Y, "Performance modeling of automated manufacturing systems", PrenticeHall,1992.
4) Nanua Singh-Computer aided design/Manufacturing.

PRODUCT LIFECYCLE MANAGEMENT (3:0:0)

Sub Code	**: MPT2E303**	**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. 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. **10 Hrs**

SLE: Slicing and dicing the systems.

References:

1. Integrated Product Development M.M. Anderson and L Hein IFS Publications.
2. Design for Concurrent Engineering J.Cleetus CE Research Centre, Morgantown.
3. Concurrent Engineering Fundamentals: Integrated Product Development, Prasad Prentice hall India, 1996.
4. Concurrent Engineering in Product Design and Development I Moustapha New Age International.
5. Product Lifecycle Management John Stark Springer-Verlag, UK.
6. Product Lifecycle Management Michael Grieves McGraw Hill, 1st edition, 2003.
7. Concurrent Engineering: Automation tools and Technology Andrew Kusiak, Wiley-Inter science publisher.

QUANTITATIVE TECHNIQUES IN DECISION MAKING (3:0:0)

Sub Code	**: MPT2E304**	**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. 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:

Introduction: Statistics and managerial decisions, Statistical data and Operations Research techniques.

Presentation and Analysis of Statistical Data: Tables and graphs as data presentation devices, Histogram and cumulative frequency curves. **08Hrs**

SLE: Frequency Distribution.

Module 2:

Fundamentals of Statistics, Probability and Probability Distributions: Measures of central tendency and location, Measure of dispersion, Skewness and kurtosis, Probability and rules of probability, Random variables and probability distributions – Binomial, Poisson, Hyper geometric and Normal.

Decision making under Uncertainty: Alternative criteria for decision under uncertainty. **08 Hrs**

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.

Linear Programming Problem: Formulation of L.P.P., Solution of L.P.P. by graphical method, Solution of L.P.P. by simplex method, Concept of duality and solution of dual problems. **08 Hrs**

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. **08Hrs**

SLE: Scheduling of a project.

References:

1. Srivastava U.K. et. All – "Quantitative Techniques for managerial decisions", New Age International Private Limited,2011.
2. Gupta and Heera – "Operations Research: An Introduction", S.Chand and Company,2012.
3. H.Taha "Operations Research", Prentice Hall India 6th edition.
4. Hillier and Liberman "Introduction to Operations Research", McGraw Hill International, 2011.

ELECTIVE IV

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

Course Code : MPT2E402	**CIE : 50% Marks**
Hrs/Week : 03	**SEE : 50% Marks**
SEE Hrs : 03	**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

Principle of Computer Modeling and Simulation: Monte Carlo simulation. Nature of computer- modeling and simulation. Limitations of simulation. **07 Hrs**

SLE: Areas of applications.

Module 2

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

Discrete Event Simulation: Concepts in discrete event simulation, manual simulation using event scheduling, two server queue, simulation of inventory problem.

10 Hrs

SLE: Single Channel Queue.

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-Smimov test, Ulfaskluna and Annita borsen Dohlgvist Publisher Artechhouse.

12Hrs

SLE: Chi-square Test.

Module 4:

Random Variable Generation: Inversion transforms technique, exponential distribution. Uniform distribution, Weibull distribution, continuous distribution, generating approximate normal variates **08 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. **08 Hrs**

SLE: Gamma Distribution.

References:

1. Discrete Event System Simulation - Jerry Banks and .John S Carson II - Prentice Hall Inc.-1984.
2. Systems Simulation - Gordan. G. - Prentice Hall India Ltd - 2004.
3. System Simulation with Digital Computer - Nusing Deo - Prentice Hall of India - 1979.
4. Computer Simulation and Modeling - Francis Neelamkovil - John Wiley and Sons - 1987.
5. Simulation Modeling with Pascal - Rath M. Davis and Robert M O Keefe - Prentice Hall Inc. - 1989.

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:

Radiography Inspection: Principles, Radiation sources- X-rays and gamma rays, X-ray tube, Radio graphic films, Neutron radiography, Equipment, Inspection methods, Applications.

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

SLE: Indian standards for NDT

References:

1. Mc Gonnagle J J "Non Destructive Testing" – Garden and reach New York.
2. Non destructive Evolution and quality control" volume 17 of metals hand book 9 edition 1989.
3. Davis H.E Troxel G.E wiskovil C.T, "The Testing Instruction of Engineering materials", Mc graw hill.

PRINCIPLES OF RELIABILITY ENGINEERING (3:0:0)

Course Code : MPT2E404	**CIE : 50% Marks**
Hrs/Week : 03	**SEE : 50% Marks**
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

Introduction: What is reliability engineering? Why teach reliability engineering? Why do engineering items fail? Probabilistic reliability, Repairable and non repairable items, Reliability Program activities, Reliability Economics and Management, The development of reliability engineering, The study of reliability and maintainability, Concepts, terms and definitions, Applications.

Time dependent failure models: The Weibull distribution, Normal distribution, The Log Normal distribution.

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

Failure Data Analysis: Data Collection, Empirical Methods, Static Life Estimation, Product Testing, Reliability Life Testing, Test Time Calculations, Burn-In Testing, Acceptance Testing, Accelerated Life Testing, Experimental Design, Competing Failure Modes, Identifying Candidate Distributions, Parameter Estimation for Covariate Models, Accelerated Test Data Analysis, Reliability Analysis of Repairable Systems, Reliability Demonstration. **08Hrs**

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.

Physical reliability models: Distributed load and strength, Analysis of Load Strength Interferences, Effect of Safety Margin and Loading Roughness on Reliability. Covariate models, Static Models, Dynamic Models , Mechanical Stress, Strength, Fracture, Fatigue, Creep, Wear, Corrosion, Reliability of Electronic components, Circuit and system aspects, Electronic system reliability prediction, Reliability in electronic system design, Software in engineering systems, Software Errors, Preventing errors. **08 Hrs**

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

Module 5

Reliability Management: Corporate Policy for Reliability, Integrated Reliability Programmes, Reliability and Costs, Safety and Product Liability, Standards for Reliability, Quality and Safety, Specifying Reliability, Contracting for Reliability Achievement, Managing Lower–level Suppliers, The Reliability Manual, The Project Reliability Plan, Use of External Services, Customer Management of Reliability, Selecting and Training for Reliability, Organization for Reliability, Managing Production Quality, Quality Audit, Quality Management Approaches. **10 Hrs**

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

Reference Books:

1. Charles E. Ebling, An Introduction to Reliability and Maintainability Engineering, Tata McGraw Hill MLM1004, 2000, ISBN: 007 0421382.
2. Patrick D.T. Oconnor, et. al., - Practical Reliability Engineering, John Wiley and Sons, 2002, 4th Edition, ISBN: 9812-53-045-2.
3. Dr. E. Balaguruswamy – Reliability Engineering, McGraw Hill, 2003, 4th Edition
4. L.S. Srinath, Reliability Engineering, Affiliated East West Press Pvt Ltd, 1991, 3rd Edition, ISBN: 81 85336393.

OPERATIONS RESEARCH (3:0:0)

Course Code : MPT2E405	**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. 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. **12Hrs**

SLE: Degeneracy Problem, Multiple Solution Problems

Module 2

Dynamic Programming: Introduction features and characteristics, recursive equation, Bellman's principle, minimum path problem, cargo loading problem, reliability problem. **08Hrs**

SLE: Capital Budgeting Problem.

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. **08Hrs**

SLE: Birth and Death Process Derivations.

Module 4

Simulation: Introduction, uses of simulation, simulation terminology, Monte-Carlo simulation, generation of random numbers, typical problems. **06Hrs**

SLE: Simulation Languages.

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. **08 Hrs**

SLE: Staffing Problems.

References

1. Taha H.A-Operations Research, Mc Millan.
2. Philips, Ravindran and Soleberg- Principles of Operations Research-Theory and Practice, Wiley India Pvt. Ltd.-New Delhi, 2nd edition, 2007.
3. S.D. Sharma – Operations Research, Kedarnath, Ramnathand Co.
4. Hiller and Liberman – Introduction to Operations Research, McGraw Hill.9th edition, 2011.
5. Kanthiswarup – Operations Research, Sultanchand and sons, 2009.

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

Course Code : MPT2L01 **CIE : 50% Marks**
Hrs/Week 02 **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.
4. Speed control of cylinder: meter-in and meter-out circuits.
5. Exercises on Electro Hydraulic circuit using Automation Studio - Single solenoid circuit, double solenoid circuit, Delay relay circuits, circuits using Proximity sensors.
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,

Project Planning and Estimating: Technical Feasibility, Estimating Financial Feasibility, NPV, IRR. Comparison of alternatives with unequal lives **7Hrs**

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
3. **Project Management** Bhavesh M.Patel, Vikas Publication House, 2002.
4. **PERT & CPM.** L.S. Srinath, Affiliated East West Press Pvt. Ltd 2002.
5. **Project planning scheduling & control** James P.Lawis, Meo PublishingCompany, 5th edition 2010.
6. **"Project Management a System approach to planning Scheduling & Controlling"**–Harold Kerzner,10th edition 2009, John wiley& sons.

III SEMESTER

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.

8Hrs

SLE: Case study on lean tool implementation.

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. **8Hrs**
SLE: Multi-function workers.

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

10Hrs

SLE: Implementation of Jidoka.

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.

8 Hrs

Managing lean enterprise: Global enterprises and their benefits.

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

Text books

1. **Pascal Dennis, Lean Production Simplified**: **A Plain-Language Guide to the World's Most Powerful Production System,** (Second edition), Productivity Press, New York, 8th edition 2014.
2. **Lean and Agile Manufacturing** : Theoretical, Practical and Research Futurities, S.R. Devadasan, V.Mohan Sivakumar, R.Murugesh, P.R.Shalij, 2012 edition.

References:

1. "**The Machine that changed the World**" by Daniel Roos, 2007.
2. **Toyo to production system** –An integrated approach to just in time by Yasuhiro Monden – Engineering and Management press – Institute of Industrial Engineers Norcross Georgia 3rd edition 1998.
3. Mike Rother and John Shook, Learning to See: **Value Stream Mapping to Add Value and Eliminate MUDA**, Lean Enterprise Institute, 1999.
4. **Japanese Manufacturing Techniques**. **The Nine Hidden Lessons by simplicity** by Richard Schourberger, 1982.
5. **"Just in Time Manufacturing**" , M. G. Korgaonker MacMillan. Reprinted 2011
6. "**Lean thinking**" James P.Womack and Daniel T.Jones, 1996.

IV SEMESTER

PROJECT WORK- PHASE-II

Sub Code	**: MPT4C01**	**Mid-Term Evaluation**	**: 50% Marks**
Duration	**: 16 Weeks**	**Final Evaluation**	**: 50% Marks**
Max. Marks	**: 100**		

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.