Dr. MAHALINGAM COLLEGE OF ENGINEERING AND TECHNOLOGY

An Autonomous Institution Since 2011

Udumalai Road, Pollachi, Coimbatore District - 642003

Established in 1998 ♦ Approved by AICTE ♦ Affiliated to Anna University

(A DIVISION OF NIA EDUCATIONAL INSTITUTIONS)

NAAC A++ GRADE Cycle 3 (2023-2030) The Highest Grade

Curriculum and Syllabi

Semesters I & II

Regulations 2024

Programme: M.E. CAD/CAM
Curriculum and Syllabi: Semesters – I & II
Recommended by Board of Studies on
Approved by Academic Council on

Action	**Responsibility**	**Signature of Authorized Signatory**
Designed and Developed by	BoS Mechanical Engineering	
Compiled by	Office of the Controller of Examinations	
Approved by	Principal	

Dr. Mahalingam College of Engineering and Technology, Pollachi – 642003.
(An autonomous institution approved by AICTE and affiliated to Anna University)

Department of Mechanical Engineering

Vision:

To transform students from rural background into professional leaders of tomorrow in the field of Production Engineering with a strong sense of social commitment

Mission:

- To impart quality -Engineering education leading to specialization in the emerging areas of CAD/CAM/CAE, Tool & Die Making, Product Styling & Design, Machine Vision Systems and Materials Technology.
- To provide - continually updated and intellectually stimulating environment to pursue research and consultancy activities.

Programme: M.E. CAD/CAM

Programme Educational Objectives (PEOs) - Regulation 2024

After 2 to 3 years of completion of the programme the graduates will be able to:

PEO1. Actively advance, engineering of products with elaborate modeling, simulation and analysis by scholarly research

PEO2. Constantly improves systems for increasing productivity in organizations.

Programme Outcomes (POs) - Regulations 2024

On successful completion of the programme the graduates will be able to:

PO1. Solve engineering problems after evaluating a wide range of potential solutions for those problems and arrive at feasible, optimal solutions with due consideration for public health, safety, cultural, societal and environmental factors.

PO2. Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data.

PO3. Communicate with the engineering community and with society at large, regarding complex engineering activities by being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, and making effective presentations.

PO4. Use engineering, management and IT tools for prediction and modeling of complex engineering activities with an understanding of the limitations.

An Autonomous Institution Since 2011.
Approved by AICTE / Affiliated to Anna University.
Accredited by NAAC with 'A++' Grade.
Tier-1* - Accredited by NBA.
Part of NIA Educational Institution

Dr. Mahalingam College of Engineering and Technology, Pollachi
Department of Mechanical Engineering
M.E CAD/CAM
2024 Regulations – Curriculum for Semesters I to IV

Semester I

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
24MAT101	Mathematical Methods in Engineering	3	1	0	3	100	All
24CCT102	Advanced Finite Element Analysis	3	0	0	3	100	-
24CCT103	Design for X	3	0	0	3	100	-
24XXXXX	Professional Elective I	3	0	0	3	100	-
24CCT101	Research Methodology and IPR	3	0	0	3	100	All
24CCL101	CAD/CAM Laboratory	0	0	4	2	100	-
24CCL102	CAE Laboratory	0	0	4	2	100	
24SHA101	English for Research Paper Writing(Audit Course)	2	0	0	-	100	All
Total		**17**	**1**	**8**	**19**	**800**	

Semester II

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
24CCT201	Mechanical Vibration and Noise Engineering	3	0	0	3	100	-
24CCT202	Applied Materials Engineering	3	0	0	3	100	-
24CCT203	New Product Development	3	0	0	3	100	-
24XXXXX	Professional Elective II	3	0	0	3	100	-
24XXXXX	Professional Elective III	3	0	0	3	100	-
24CCL201	New Product Development Laboratory	3	0	0	3	100	-
24CCL202	Research Paper seminar	0	0	2	1	100	-
24SHA201	Teaching and Learning in Engineering	0	0	4	-	100	All
Total		**18**	**0**	**6**	**19**	**800**	

Semester III

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
24XXXXX	Professional Elective – IV	3	0	0	3	100	-
24XXXXX	Professional Elective – V	3	0	0	3	100	-
24XXXXX	Open Elective/Online Course	3	0	0	3	100	
24CCP301	Project – I	0	0	20	10	200	-
Total		**9**	**0**	**20**	**19**	**500**	

Semester IV

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
24CCP401	Project – II	0	0	32	16	400	-
Total		**0**	**0**	**32**	**16**	**400**	

Total Credits: 73

Professional Electives

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
24CCE001	Computer Integrated Manufacturing	3	0	0	3	100
24CCE002	Industry 4.0	3	0	0	3	100
24CCE003	Corrosion and Surface Engineering	3	0	0	3	100
24CCE004	Industrial Robotics and Artificial Intelligence	3	0	0	3	100
24CCE005	Additive Manufacturing	3	0	0	3	100
24CCE006	Experimental Methods and Analysis	3	0	0	3	100
24CCE007	Product Life Cycle Management	3	0	0	3	100
24CCE008	Mechanics of Composite Materials	3	0	0	3	100
24CCE009	Optimization Techniques in Design	3	0	0	3	100
24CCE011	Computational Fluid Dynamics	3	0	0	3	100
24CCE012	Flexible Competitive Manufacturing Systems	3	0	0	3	100
24CCE013	Product Data Management	3	0	0	3	100
24CCE014	Metrology and Non Destructive Testing	3	0	0	3	100
24CCE015	Computer Aided Process Planning	3	0	0	3	100
24CCE016	Material Testing and Characterization	3	0	0	3	100

SEMESTER I

<table>
<tr><td colspan="2">Course Code: 24MAT101</td><td colspan="2">Course Title: MATHEMATICAL METHODS IN ENGINEERING</td></tr>
<tr><td colspan="2">Course Category: Foundation Courses</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 1: 0</td><td>Credits:
3</td><td>Total Contact Hours: 45</td><td>Max Marks:100</td></tr>
</table>

Course Objectives:

The course is intended to:

1. Solve the variational problems with boundary conditions.
2. Solve the system of linear equations and apply numerical techniques to evaluate integrals.
3. Identify and solve engineering problems by applying the knowledge of partial differential equations.
4. Interpret the notion of sampling distributions and statistical techniques used in engineering problems.
5. Explain the systematic problem solving techniques using design of experiments.

MODULE I **22 Hours**

Variational approach and Solution to set of Equations

Variation and its properties –Euler's equation – Functionals dependent on first and higher order derivatives - Functionals dependent on functions of several independent variables – Rayleigh Ritz method- Galerkin method.

Solving the set of equations, Choleski method, Iterative methods, Relaxation method, Trapezoidal rule, Simpson's rules, Gaussian quadrature, Examples.

Solution to Higher Order Partial Differential Equations

Second order linear equations and their classification, Initial and boundary conditions, DAlembert's solution of the wave equation. Separation of variables method to simple problems

MODULE II **23 Hours**

Testing of Hypotheses and Design of Experiments

Statistical hypothesis, Large sample test based on Normal distribution for single mean and difference of means, Tests based on t, Chi-square and F distributions for mean, variance and proportion, Contingency table (test for independent),Goodness of fit.

Aim of Design of Experiments-Basic Principles of Experimental Design-Completely Randomized Design (CRD)-Analysis of Variance (AVOVA) - Randomized Design (RBD)-Latin Square Design(LSD)-Comparison of RBD and LSD.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Solve the set of equations using variational method and numerical method	**Apply**
CO2: Test the hypothesis and conduct experiments to decide the effect of responses	**Apply**
CO3: Select an experiment no of inputs and its effect on response through a case study.	**Apply**

Reference Book(s):

R1. T.Veerarajan, “Probability, Statistics and Random Process”, 3rd Edition, Tata McGraw-Hill, New Delhi,2017

R2. Erwin Kreyszig , “Advanced Engineering Mathematics”, (10th Edition), , John Wiley India,2013

Curtis F Gerald and Patrick O Wheatley, "Applied Numerical Analysis", Seventh Edition, Pearson, New Delhi, 2007

R3. R4. P.Kandasamy,K.Thilagavathy, K.Gunavathy, “Numerical Methods” S.CHAND, Latest Edition 2006

Course Code: 24CCT102		**Course Title: ADVANCED FINITE ELEMENT ANALYSIS**	
Course Category: Professional Core		**Course Level: Introductory**	
L:T:P(Hours/Week) 3: 0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

This course intended to learn advanced concepts in finite element analysis useful for study of complex mechanical systems.

MODULE I **22 Hours**

NON LINEAR ELASTIC PROBLEMS

Preliminary concepts: Index notation and summation rule, Vector and tensor calculus, Mechanics of continuous bodies, Boundary-value problem, Principle of minimum potential energy, and Principle of virtual work, Finite element formulation. Plane stress, Plane strain conditions, Stress strain relationship for anisotropic materials.

Introduction to nonlinear FEA procedures: Linear vs. nonlinear problems, Solution procedure, Newton-Raphson method, Incremental N-R method, Incremental secant method FEA for nonlinear elastic problems: Nonlinear elastic problems.

MODULE II **23 Hours**

DYNAMIC ANALYSIS - Dynamic equation of motion- Consistent mass matrix, lumped mass matrix- frame element, triangular membrane element, triangular tetrahedron element formulation of lumped and consistent mass matrices, Eigen Values and Eigen Vectors for a stepped bar, beam; Finite element formulation to 3D problems in stress analysis.

Eigen value problems-Natural frequencies of beams

Dynamic response calculations-solution to second order systems- undamped and damped system.

Unsteady state heat transfer problems-one dimensional, two dimensional, axisymmetric problems

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Apply the FEA concepts to solve nonlinear elastic problems	**Apply**
CO2: Apply the FEA concepts to solve Eigen Value and Eigen vector problems and unsteady state heat transfer problems.	**Apply**

Reference Book(s):

R1. Tirupathi K. Chandrupatla and Ashok D. Belagundu, “Introduction to Finite Elements in Engineering”, Pearson, 4th Edition, 2011.

R2. S.S. Rao, “The Finite Element Methods in Engineering”, Elsevier, 4th Edition 2009.

R3. O.C. Zienkowitz, “The Finite Element Method in Engineering Science”, McGraw Hill. 4th Edition, 2009.

R4. Robert Cook, “Concepts and Applications of Finite Element Analysis”, Wiley, 4th Edition, 2010.

R5. J. N. Reddy, “An Introduction to Finite Element Methods”, McGraw Hill, 4th Edition 2009.

Course Code: 24CCT103		Course Title: DESIGN FOR X	
Course Category: Professional Core		Course Level: Introductory	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to describe the factors involved in designing a part, assembly and other factors.

Course Objectives

The course is intended to:

1. Elaborate the design principles for manufacturability.
2. Discuss the factors influencing in form design.
3. Apply the component design features of various machining.
4. Apply the component design features of casting consideration.
5. Apply design consideration principles for additive manufacturing.

MODULE I **22 Hours**

INTRODUCTION TO DESIGN FOR X

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances, Geometric tolerances - Assembly limits -Datum features - Tolerance stacks.

Design to minimize material usage – Design for disassembly – Design for recyclability – Design for manufacture – Design for energy efficiency – Design to regulations and standards.

Working principle, Material, Manufacture, Design- Possible solutions - Materials choice — Influence of materials on form design - form design of welded members, forgings and castings.

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability — Design for accessibility - Design for assembly – Product design for manual assembly - Product design for automatic assembly — Robotic assembly.

MODULE II **23 Hours**

DESIGN CONSIDERATIONS FOR CASTING & ADDITIVE MANUFACTURED PARTS

Redesign of castings based on parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA.

Introduction to AM, DFMA concepts and objectives, AM unique capabilities, exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Apply the concepts of Design for X	**Apply**
CO2: Apply the various factors for Design.	**Apply**
CO3: Develop a design plan for a part considering all factors involved in a design.	**Apply**

Reference Book(s):

R1 James G. Bralla, “Design for Manufacturability Handbook”, McGraw Hill Professional, 2nd edition, 2020.

R2. O. Molloy, E.A. Warman, S. Tilley, Design for Manufacturing and Assembly: Concepts, Architectures and Implementation, Springer,1998.

R3. CorradoPoli, Design for Manufacturing: A Structured Approach, Elsevier, 2001.

R4. David M. Anderson, Design for Manufacturability & Concurrent Engineering: How to Design for Low Cost, Design in High Quality, Design for Lean Manufacture, and Design Quickly for Fast Production, CIM Press, 2004.

R5. Erik Tempelman, Hugh Shercliff, Bruno Ninaber van Eyben, Manufacturing and Design: Understanding the Principles of How Things Are Made, Elsevier, 2014.

Course Code: 24CCT101		Course Title: RESEARCH METHODOLOGY AND IPR	
Course Category: Professional Core		Course Level: Introductory	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to describe the attitude measurements, scales and sampling methods and to apply hypotheses testing in research problem. Elucidate the research report writing and presentation effectively to encourage applying for patent and copyrighting for their innovative works.

MODULE I **22 Hours**

OVERVIEW OF RESEARCH METHODOLOGY

Research methodology — definition, mathematical tools for analysis, Types of research, exploratory research, conclusive research, modeling research, algorithmic research, Research process Data collection methods- Primary data — observation method, personal interview, telephonic interview, mail survey, questionnaire design. Secondary data- internal sources of data, external sources of data.

ATTITUDE MEASUREMENTS, SCALES AND SAMPLING METHODS

Scales – measurement, Types of scale – Thurstone's Case V scale model, Osgood's Semantic Differential scale, Likert scale, Q- sort scale. Sampling methods- Probability sampling methods — simple random sampling with replacement, simple random sampling without replacement, stratified, sampling, cluster sampling. Non- probability sampling method– convenience.

MODULE II **23 Hours**

HYPOTHESES TESTING

Hypotheses testing — Testing of hypotheses concerning means (one mean and difference between two means -one tailed and two tailed tests).

REPORT WRITING AND PRESENTATION

Report writing- Types of report, guidelines to review report, typing instructions, oral presentation.

PATENTING

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1: Apply the attitude measurements, scales and sampling methods	**Apply**
CO2: Apply hypotheses testing in research problem.	**Apply**
CO3: Apply the patent and copyright for their innovative works	**Apply**

Reference Book(s):

R1. Panneerselvam, R.,Research Methodology, Prentice-Hall of India, New Delhi, 2004.

R2. Kumar, Ranjit, , “Research Methodology: A Step by Step Guide for beginners”, London Sage: Publications, 2005.

R3. Halbert, “Resisting Intellectual Property”, Taylor & Francis Publications,2007.

R4. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in NewTechnological Age”, Clause 8 Publishing,2016.

R5. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand Publications, 2008.

Course Code: 24CCL101		Course Title: CAD/CAM LABORATORY	
Course Category: Professional Core		**Course Level : Practice**	
L:T:P(Hours/Week) 0:0:4	**Credits: 2**	**Total Contact Hours:45**	**Max Marks:100**

Course Objectives:

The course is intended to:
1. Develop assembly drawings using standard CAD packages.
2. Demonstrate practical experience in handling 2D drafting and 3D modeling software systems.
3. Write CNC programming to machine the mechanical components.

List of Experiments: **45 Hours**

1. Preparation 2D Drafting of Non-return valves.
2. Preparation 2D Drafting of Safety valve
3. Preparation of Knuckle joint assembly drawing
4. Preparation of 3D Assembly of Piston and connecting rod
5. Preparation of 3D Assembly Machine vice
6. Preparation of 3D Assembly Stuffing box
7. Programming and simulation for machining of internal surfaces in CAM software.
8. Programming and simulation for circular and rectangular pocket milling
9. Programming and simulation using canned cycle for CNC Milling such as peck drilling and tapping cycle
10. Turning operation using CAM software.
11. Milling operation using CAM software.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1: Assembly and Drafting of mechanical components using CAD software package.	**Apply**
CO2: Develop the CNC programming to machine the mechanical components.	**Apply**

Reference Book(s):

R1. K.L.Narayana, P.Kannaiah, K.Venketa Reddy, “ Text book for Machine Drawing” New Age International Pvt Ltd,2009

R2. Radhakrishnan .P, “Computer Numerical Control CNC Machines”

New central book agency, 2013

Course Code: 24CCL102		Course Title: CAE LABORATORY	
Course Category: Professional Core		**Course Level : Practice**	
L:T:P(Hours/Week) 0:0:4	**Credits: 2**	**Total Contact Hours:45**	**Max Marks:100**

Course Objectives:

The course is intended to provide practical knowledge in structural, thermal and vibration problems in mechanical engineering using finite element simulation software and MAT lab.

List of Experiments:

Analysis **45 Hours**

1. Stress analysis of a plate with a circular hole.
2. Perform coupled field analysis –thermal / structural
3. Vibration analysis of spring-mass systems.
4. Perform contact analysis of surface to surface
5. Harmonic, transient and spectrum analysis of simple systems.
6. Mode frequency analysis of beams(Cantilever, Simply supported, Fixed ends)
7. Thermal stress analysis of a 3D component

Simulation

1. Solve simple vibration problems by using MATLab.
2. Solve cam and follower system by using MAT Lab

Course Outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO1:Solve structural, thermal and vibration problems in mechanical engineering using finite element simulation software	**Apply**
CO2: Construct engineering model, analyze and simulate experiments to meet real world engineering system.	**Apply**

Reference Book(s):

R1. DivyaZindani, Apurba Kumar Roy, Kaushik Kumar," Working with ANSYS: A Tutorial Approach", I K International Publishing House Pvt. Ltd,2017

R2. CAE Laboratory manual.

<table>
<tr><td colspan="2">Course Code: 24SHA101</td><td colspan="2">Course Title: ENGLISH FOR RESEARCH PAPER WRITING
(Common to all PG Programme)</td></tr>
<tr><td colspan="2">Course Category :Humanities</td><td colspan="2">Course Level : Introductory</td></tr>
<tr><td>L:T:P(Hours/Week)
2:0:0</td><td>Credits: -</td><td>Total Contact Hours: 30</td><td>Max Marks : 100</td></tr>
</table>

Course Objectives:

The course is intended to enhance the language skills concerning research paper writing and to explain the crucial role of technology in enhancing the quality and credibility of research.

Module I **15 hours**

Foundations of Academic English in Research: Academic English - Key Language Aspects - Clarity and Precision - Objectivity - Formal Tone - Integrating References.

Effective Writing Style for Research Papers: Word Order - Sentences and Paragraphs - Link Words for Cohesion - Avoiding Redundancy / Repetition - Breaking up long sentences - Paraphrasing Skills.

Advanced Reading and Research Vocabulary Development: Critical Reading Strategies - Analysing Research Articles - Identifying Arguments - Evaluating Findings - Formulaic Expressions - Academic Phrase Bank - Discipline-Specific Vocabulary - Commonly Misused Words.

Module II **15 hours**

Presentation Language Skills: Written vs. Spoken English - Dynamic Vocabulary for Presentations -Expressive Language for Audience Engagement- Language for Clear and Impactful Slides - Adapting Language Style to Different Audiences.

Grammar Refinement for Research Writing: Advanced Punctuation Usage- Proper Use of Modifiers - Avoiding Ambiguous Pronoun References - Verb Tense Consistency - Conditional Sentences.

Technology and Language for Research: Technology and Role of AI in Research Writing - Citations and References - Plagiarism and Ethical Considerations - Tools and Awareness - Fair Practices.

Course Outcomes	Cognitive Level
At the end of the course the student will be able to :	
CO 1: Enhance their English Language Skills concerning research paper writing	**Understand**
CO 2: Develop a comprehensive set of linguistic skills essential for academic research.	**Apply**
CO 3: Produce well-structured research papers using a variety of research and presentation technologies.	**Apply**

Reference Book(s):

R1: Craswell, G. 2004. Writing for Academic Success. Sage Publications. Springer, New York

R2: Wallwork, Adrian. 2015. English for Academic Research: Grammar, Usage and Style

R3: Swales, J. & C. Feak. 2012. Academic Writing for Graduate Students: Essential Skills and Tasks. Michigan University Press.

R4: English for Writing Research Papers, 2011. Springer, New York.

Web References:

1. https://tiramisutes.github.io/images/PDF/English+for+Writing+Research+Papers.pdf
2. https://libguides.usc.edu/writingguide/grammar
3. https://onlinecourses.swayam2.ac.in/ntr24_ed15/preview

Assessment Pattern

	Assessment Component	Co. No.	Marks	Total
Continuous Comprehensive Evaluation(Internal)	Assignment 1	1	20	100
	Assignment 2	2	20	
	Assignment 3	3	20	
	MCQ	1,2,3	20	
	Descriptive Pattern Test	1,2,3	20	

Student will be finally awarded with three levels based on the score as follows:

Marks Scored	**Levels**
70% & above	Good
30-69 %	Average
< 30 %	Fair

SEMESTER II

<table>
<tr><td colspan="2">Course Code: 24CCT201</td><td colspan="2">Course Title: MECHANICAL VIBRATIONS AND NOISE ENGINEERING</td></tr>
<tr><td colspan="2">Course Category: Professional Core</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 0</td><td>Credits:
3</td><td>Total Contact Hours: 45</td><td>Max Marks:100</td></tr>
</table>

Course Objectives:

Objective of the subject is to deal with study of basics of the vibrations in a body, analysis of vibration phenomenon, control of vibration. The subject also deals with Introduction of basic terminology of noise engineering and noise control.

MODULE I **25 Hours**

SYSTEMS WITH 2 DOF

Principal modes of vibrations, normal mode and natural frequencies of systems (Damping is not included), simple spring-mass systems, masses on tightly stretched strings, double pendulum, tensional systems, combined rectilinear and angular systems, geared systems and numerical problems.

NUMERICAL METHODS FOR MULTI DOF SYSTEMS

Maxwell's reciprocal theorem, influence coefficients, Rayleigh's method, Dunkerley's method, stodola method, orthogonality principle, method of matrix iteration and numerical

VIBRATION MEASURING INSTRUMENTS and ANALYSIS

seismic instruments, vibrometers, accelerometer, frequency measuring instruments, modal and harmonic analysis.

MODULE II **20 Hours**

VIBRATION CONTROL

Introduction, Vibration isolation theory, Vibration isolation and motion isolation for harmonic excitation, practical aspects of vibration analysis, vibration isolation, Dynamic vibration absorbers and Vibration damper.

NOISE ENGINEERING

Subjective response of sound: Frequency and sound dependent human response; the decibel scale; relationship between , sound pressure level(SPL), sound power level and sound intensity scale; relationship between addition, subtraction and averaging, sound spectra and Octave band analysis ; loudness; weighting networks; equivalent sound level, auditory effects of noise; hazardous noise, exposure due to machines and equipment; hearing conservation and damage risk criteria.

NOISE: SOURCES, ISOLATION AND CONTROL

Major sources of noise on road and in industries, noise due to construction equipment and domestic appliances, industrial noise control, strategies-noise control at source (with or without sound enclosures), noise control along the path (with or without partitions and acoustic barriers); noise control at the receiver, ear defenders, earplugs, semi-insert protectors.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Apply the appropriate methods to find the natural frequency of multi DOF system	**Apply**
CO3: Apply the principles of vibration and noise reduction techniques to real life engineering problems.	**Apply**

Reference Book(s):

R1. Ambekar A.G. “Mechanical Vibrations and Noise Engineering” Prentice-Hall of India, New-Delhi, 2e, 2006.

R2. Thomson W.T “Theory of Vibration with Application” CBS Publishers & Distriburors, Delhi, 3e, 2002.

R3. Vibraitons and Acoustics – Measurements and signal analysis C Sujatha Tata McGraw Hill,2010

R4. Singiresu Rao, “Mechanical Vibrations , Pearson Education ,2004

R5. Kewal Pujara “Vibrations and Noise for Engineers”, Dhanpat Rai & Sons, 2001.

Course Code: 24CCT202		Course Title: APPLIED MATERIALS ENGINEERING	
Course Category: Professional Core		Course Level: Introductory	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:
The course is intended to impart knowledge on elastic, plastic behaviors and fracture of modern materials.

MODULE I **22 Hours**

ELASTIC AND PLASTIC BEHAVIOUR

Elasticity in metals and polymers - Mechanism of plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals - Strengthening mechanisms, work hardening, solid solution strengthening, grain boundary strengthening, poly phase mixture, precipitation, particle, fiber and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviors - Super plasticity

FRACTURE BEHAVIOUR

Griffith theory, stress intensity factor and fracture toughness - Toughening mechanisms - Ductile, brittle transition in steel - High temperature fracture, creep - Deformation and fracture mechanism maps - Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law - Effect of surface and metallurgical parameters on fatigue- failure analysis - source of failure analysis

MODULE II **23 Hours**

MODERN METALLIC MATERIALS

Dual phase steels, Micro alloyed, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) steel, Maraging steel - Intermetallics, Ni and Ti aluminides - Smart materials, shape memory alloys - Metallic glass - Quasi crystal and nano crystalline materials, Advanced Composites-Particulate and dispersioned composites, Metal matrix and ceramic matrix composites, Carbon-Carbon composites

NON METALLIC MATERIALS

Ti and Ni based alloys for gas turbine applications, Managing and cryogenic steels-Newer materials and their treatment for automobile applications, materials for Naval and nuclear systems. Smart and Nano materials

SELECTION OF MATERIAL

Motivation for selection, cost basis and service requirements -Selection for mechanical properties, strength, toughness, fatigue and creep -Selection for surface durability corrosion and wear resistance –Relationship between materials selection and processing -Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications .

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Apply the knowledge to solve problems related to isotropic elasticity such as elastic, plastic behaviours of materials.	**Apply**
CO2: Apply the knowledge to adopt the acceptable level of risk for a component or application subjected to fracture, fatigue failure.	**Apply**
CO3: Select a suitable material to meet the design specification by evaluating the relationship between material properties, microstructures and processing.	**Apply**

Reference Book(s):

R1. Dieter G. E., “Mechanical Metallurgy”, McGraw Hill Book Company, 2013.

R2. Sidney H Avner “Introduction to Physical Metallurgy”, Tata McGRAW-Hill, 2017.

R3. Raghavan.V “Materials Science and Engineering”, Prentice Hall of India Pvt., Ltd., 2015.

R4. William D Callister “Material Science and Engineering”, John Wiley and Sons, 2014.

Course Code: 24CCT203		Course Title: NEW PRODUCT DEVELOPMENT	
Course Category: Professional Core		Course Level: Introductory	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is used to identify the customer needs for produced development and select the approaches for materials and manufacturing. Understand the value analysis in cost and teardown process.

MODULE I **22 Hours**

PRODUCT DEVELOPMENT

Need for developing products, the importance of engineering design, types of design, the design process. product lifecycle- relevance of product lifecycle issues in design, design using codes and standards. societal considerations in engineering design, fisher product classification, generic product development process, various phases of product development, planning for products, establishing markets, market segments, relevance of market research- market requirement specification and product requirement specification.

PRODUCT MORPHOLOGY METHODS AND ANALYSIS

Identifying customer needs –voice of customer –customer populations- hierarchy of human needs-need gathering methods — affinity diagrams — needs importance- identify the technical requirement of customer need - establishing engineering characteristics. . . competitive benchmarking- quality function deployment- house of quality. product design specification- generating design concepts -systematic methods for design–functional decomposition – physical decomposition –functional representation. morphological methods and analysis -TRIZ- axiomatic design.

MATERIAL SELECTION FOR PRODUCTS

Selection of material for mechanical properties- Strength, toughness and fatigue- Material selection for durability, surface wear and Corrosion resistance- Functional relation between materials and processing.

MODULE II **23 Hours**

MANUFACTURING PROCESS SELECTION

Manufacturing Processes - advantages and limitations. Selection of Processes- Process Capabilities - Design Guidelines. Product Design- Manufacturing Perspective.

VALUE ENGINEERING

Value Engineering Function- Approach of Function, Evaluation of Function, Determining

Function, Classifying Function. Evaluation of costs- Evaluation of Worth, Evaluation of Value, FAST Diagram, categories of cost — overhead costs — activity based costing — methods of developing cost estimates – manufacturing cost –value analysis in costing.

PRODUCT TEARDOWN

Teardown Process- List Design Issues-Prepare for Product Teardowns, Examine the Distribution and Installation-Disassemble, Measure and Analyse Data by Assemblies, Form a Bill of Materials. Teardown methods-Subtract and Operate Procedure, Force Flow (Energy Flow Field) Diagrams, Measurement and Experimentation, product verification and validation, Case studies.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Design the various phases, House of Quality to identify the customer needs and product design specification for a new product development.	**Apply**
CO2: Identify the appropriate materials and manufacturing process for a new product development based on manufacturing perspective.	**Apply**
CO3: Integrate the various functions of value engineering and Teardown process in new product development.	**Apply**

Reference Book(s):

R1. Clive L.Dym, Patrick Little, Engineering Design: A Project-based Introduction, 3rd Edition, John Wiley and Sons, 2019.

R2. George E.Dieter, Linda C.Schmidt, Engineering Design, McGraw-Hill International Edition, 4th Edition, 2009.

R3. YousefHaik, T. M. M. Shahin, Engineering Design Process, 2nd Edition Reprint, Cengage Learning, 2010.

Course Code: 24SHA201		Course Title: TEACHING AND LEARNING IN ENGINEERING (Common to all PG Programmes)	
Course Category: Audit Course		Course Level: Introductory	
L:T:P(Hours/Week) 0:0:4	Credits: -	Total Contact Hours: 30	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on an outcome-based approach, employing active learning methods in lecture/practical/tutorial sessions. Assessments will be conducted using rubrics, focusing on higher-order thinking skills.

Module I **15 Hours**

Outcome Based Approach

Outcome based Education- Need & Approach- Washington accord- Graduate attributes- Learning outcomes –Blooms Taxonomy.

Active Learning Methods

Design and Delivery plan for lectures/practical/tutorial sessions-Need for Active learning methods-Active learning strategies- Benefits of Active learning Methods.

Module II **15 Hours**

Assessments

Assessments- types of assessments-need for rubrics, Types of rubrics- Assessment using rubrics.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Use outcome based approach in teaching courses in engineering Programmes.	Apply
CO 2: Conduct lecture/practical/tutorial sessions using active learning methods.	Apply
CO 3: Conduct higher order assessments by using rubrics.	Apply

Reference Book(s):

1. William G. Spady and Francis Aldrine A. Uy (2014). Outcome-Based Education: Critical Issues and Answers, ISBN: 978-971-0167-41-8, Maxcor Publishing House, Inc.
2. Dr. William G. Spady, WajidHussain, Joan Largo, Dr. Francis Uy (2018). Beyond Outcomes Accreditation: Exploring the Power of 'Real' OBE Practices.
3. Richard M. Felder, Rebecca Brent (2016), Teaching and Learning STEM: A Practical Guide, John Wiley & Sons Inc

ELECTIVES

Course Code: 24CCE001	Course Title: COMPUTER INTEGRATED MANUFACTURING		
Course Category: Professional Elective	Course Level: Mastery		
L:T:P(Hours/Week): 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course objectives:

The course aims to empower students to effectively apply the concepts of computer integrated manufacturing and its principles in production industry.

Module I **23 Hours**

Introduction of CIM

Introduction to CAD, CAM, CAD/CAM and CIM - Evolution of CIM – CIM wheel and cycle – Production concepts and mathematical models – Simple problems in production models – CIM hardware and software — Major elements of CIM system — Three step process for implementation of CIM – Computers in CIM – Computer networks for manufacturing – The future automated factory – Management of CIM – safety aspects of CIM– advances in CIM

Automated manufacturing systems

Automated production line — system configurations, work part transfer mechanisms — Fundamentals of Automated assembly system — System configuration, Part delivery at workstations – Design for automated assembly – Overview of material handling equipments – Consideration in material handling system design – The 10 principles of Material handling. Conveyor systems – Types of conveyors – Operations and features. Automated Guided Vehicle system – Types &applications – Vehicle guidance technology – Vehicle management and safety. Storage system performance – storage location strategies – Conventional storage methods and equipments — Automated storage/Retrieval system and Carousel storage system

Group technology and FMS

Part families – Visual – Parts classification and coding – Production flow analysis – Grouping of parts and Machines by rank order clustering method – Benefits of GT – Case studies. FMS – Components – workstations – FMS layout configurations – Computer control systems – FMS planning and implementation issues — Architecture of FMS — flow chart showing various operations in FMS –FMS applications, Benefits.

Module II **22 Hours**

Process planning

Process planning – Activities in process planning, Information required from design to process planning – classification of manufacturing processes – Selection of primary manufacturing processes – Sequencing of operations according to Anteriorities – various examples – forming of Matrix of Anteriorities – case study. Typical process sheet – case studies in Manual process planning. Computer Aided Process Planning – Process planning module and data base – Variant process planning – Two stages in VPP – Generative process planning – Flow chart showing various activities in generative PP – Semi generative process planning- Comparison of CAPP and Manual PP.

Process control and data analysis

Introduction to process model formulation – linear feedback control systems – Optimal control — Adaptive control –Sequence control and PLC& SCADA. Computer process control — Computer process interface – Interface hardware – Computer process monitoring – Direct digital control and Supervisory computer control - Overview of Automatic identification methods – Bar code technology –Automatic data capture technologies. - Quality management (SPC) and automated inspection

Course Outcomes:

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

CO1: Choose appropriate automotive tools and material handling systems in production industry.	**Apply**
CO2: Design a layout based on group technology, FMS and automation methods.	**Analyze**
CO3: Design using computer aided process planning for manufacturing of various components.	**Analyze**
CO4: Conduct a case study in the implementation of CIM in manufacturing industry	**Analyze**

Text Book(s):

1. Shivanand H K, Benal M M and Koti V, “Flexible Manufacturing System”, New Age International Publishers, 2021
2. Wilhelm Scheer, “CIM - Computer Integrated Manufacturing: Computer Steered Industry” Springer - Verlag Berlin and Heidelberg GmbH & Co. K, 2012

3. Alavudeen A and Venkateshwaran N, "Computer Integrated Manufacturing", PHI Learning Pvt. Ltd., New Delhi, 2010.
4. Mikell P. Groover, "Automation, Production system and Computer integrated Manufacturing", Prentice Hall of India Pvt. Ltd., 4thEdition, 2014.

Reference Book(s):

1. Gideon Halevi and Ronald D. Weill, "Principles of Process Planning", Chapman Hall, 1995.
2. James A. Retrg, Herry W. Kraebber, "Computer Integrated Manufacturing", Pearson Education, Asia, 3rd Edition, 2004.
3. Radhakrishnan P, Subramanian S and Raju V, CAD/CAM/CIM, New Age International Publishers, 3rd Edition, 2008.

Web References:

1. https://onlinecourses.nptel.ac.in/noc21_me65/preview
2. https://www.classcentral.com/course/swayam-computer-integrated-manufacturing-17550

Course Code: 24CCE002		**Course Title: INDUSTRY 4.0**	
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P(Hours/Week) 3: 0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The course is intended to describe the concepts involved in industry 4.0 like hardware's, software's, communication protocols etc.,

MODULE I **22 Hours**

OVERVIEW OF INDUSTRY 4.0

Introduction to Industry 4.0 - Road to Industry 4.0- modeling and simulation, Trends in Process Simulation Engineering. centered design process – functional prototype - testing methods/ideas – prototyping and test beds – proof of concept – assembly – prototyping apps – addressing the complex problems.

Robotics, Automation, Green manufacturing, Industrial Applications- Manufacturing, Control, Maintenance and Assembly-communication protocols-Embedded Systems - Embedded firmware, Platform software design, Wireless design, Embedded testing, Hardware platform design, Device Management, Monitoring — Industrial monitoring, condition monitoring, Health monitoring. Sensor Technology and its applications, Smart Factory logistics , AI in smart manufacturing.

MODULE II **23 Hours**

Industrial Internet of Things (IIoT) , IOT platforms, IIoT Sensing, IIoT Communication, IIoT Networking- Security and Fog Computing: Cloud Computing in IIoT - Cyber Physical Systems - Digital Twins - AR/VR in Manufacturing - 3D printing in Industry 4.0 — Artificial Intellegence and Machine Learning-Big Data Analytics- Applications of UAVs in Industries -Case studies.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Apply the concepts of Industry 4.0	**Apply**
CO2: Apply the tools to achieve industry 4.0	**Apply**

Reference Book(s):

R1. Olivier Hersent, David Boswarthick, Omar Elloumi, “The Internet of Things: Key Applications and Protocols”, ISBN: 978-1-119-99435-0, 2nd Edition, Willy Publications

R2. Uthayan Elangovan, Smart Automation to Smart Manufacturing: Industrial Internet of Things, Momentum Pr, 1st Edition, 2019.

R3. Diego Galar Pascual, Pasquale Daponte, Uday Kumar, Handbook of Industry 4.0 and SMART Systems, 1st Editio, CRC Press, 2020

R4. Wang L, and Vincent W X, (2019), Cloud Based Cyber-Physical Systems in Manufacturing, Springer.

R5. Tao F, Zhang M, and Nee A Y C, (2019), Digital Twin Driven Smart Manufacturing,

Course Code: 24CCE003		Course Title: CORROSION AND SURFACE ENGINEERING	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to

To impart knowledge on corrosion engineering and surface modification of modern materials.

MODULE I **23 Hours**

Mechanisms and Types of Corrosion

Principles of direct and Electro Chemical Corrosion Mechanism, Hydrogen evolution and Oxygen absorption mechanisms — Galvanic corrosion, Galvanic series-specific types of corrosion such as uniform, Pitting, Intergranular, Cavitations Crevice Fretting, Erosion and Stress Corrosion – Factors influencing corrosion.

Testing and Prevention of Corrosion

Corrosion testing techniques and procedures- Prevention of Corrosion-Design against corrosion –Modifications of corrosive environment –Inhibitors — Cathodic Protection –Protective surface coatings

Corrosion Behavior of Materials

Corrosion of steels, stainless steel, Aluminum alloys, copper alloys, Nickel and Titanium alloys-corrosion of Polymers, Ceramics and Composite materials.

MODULE II **22 Hours**

Plating Processes

Fundamentals of electroplating, Electrodeposition from plating baths, Electroless plating, Mentalliding, Selective plating, Hard anodizing, Other plating processes

Diffusion coatings –Electro and Electroless Plating –Hot dip coating –Hard facing-Metal spraying, Flame and Arc processes- Conversion coating –Selection of coating for wear and Corrosion resistance.

Thin Film Coatings

Thermal evaporation, PVD and CVD, Sputter coating, Ion plating, Thin film for wear application, Coating specifications, Coating of tools, TiC, TiN, Al_2O_3 and Diamond coating — Properties and applications of thin coatings

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1: Apply the knowledge to solve corrosion mechanism and corrosion related problems in real world application.	**Apply**
CO2: Apply the knowledge to solve surface engineering problems in real world application.	**Apply**

Reference Book(s):

R1. Fontana. G., “Corrosion Engineering”, McGraw Hill, 2008.

R2. Kenneth G.Budinski, “Surface Engineering for Wear Resistance”, Prentice hall, 2011

R3. Winston Revie.R. Uhlig, Corrosion, Hand Book 2nd edition. John Wiley, 2008.

R4. SM Metals Hand Book –Vol. 5, “Surface Engineering”, 2010.

Course Code: 24CCE004		**Course Title: INDUSTRIAL ROBOTICS AND ARTIFICIAL INTELLIGENCE**	
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P(Hours/Week) 3: 0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The course on Industrial Robotics and Artificial Intelligence provides a comprehensive understanding of fundamental principles and advanced techniques. It focuses on developing skills in designing, programming, and controlling industrial robots, integrating vision systems and sensors, and applying AI and machine learning for autonomous decision-making. By course end, students will be equipped to contribute to research, solve complex industrial problems, and innovate in robotics and AI.

MODULE I **23 Hours**

INTRODUCTION TO ROBOTICS AND ARTIFICIAL INTELLIGENCE

Overview of Robotics: history -types -architecture of robots-robot Components and Structure-robot coordinate systems and workspace-sensors and actuators-applications. Overview of Artificial Intelligence (AI): evolution of AI -types of AI-Basic concepts in AI-Relationship between robotics and AI-Relationship between robotics and AI-Applications and impact on various industries.

ROBOT KINEMATICS AND DYNAMICS AND VISION SYSTEMS AND SENSORS IN ROBOTICS

Kinematics of Robots: Forward kinematics - Inverse kinematics. Robot Dynamics: Newton-Euler and Lagrange methods-Dynamic equations of motion. Trajectory Planning-Path planning techniques-Motion control. Introduction to Machine Vision: concept- Image processing techniques. Vision Systems for Robots: Camera calibration and 3D vision-Object recognition and tracking- Integration of Sensors: Types of sensors (proximity, tactile, ultrasonic)- Sensor fusion techniques-applications.

ROBOT PROGRAMMING AND CONTROL

Robot Programming Languages: programming languages (e.g., Python, C/C++, ROS)- Programming paradigms (teach-pendant, offline programming, online programming). Control Systems for Robots: Types of control (open and close)- PID control- Advanced control techniques (adaptive, robust, model predictive control). Simulation and Modeling Tools: Software tools (e.g., MATLAB, Simulink, Gazebo)- Simulation techniques.

MODULE II **22 Hours**

MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE TECHNIQUES FOR ROBOTICS

Introduction to Machine Learning (ML): Supervised, unsupervised, and reinforcement learning- Key algorithms (decision trees, SVM, neural networks). Deep Learning in Robotics: Convolutional neural networks (CNNs)- Recurrent neural networks (RNNs)- Applications in perception and control. AI Techniques for Robotics: Planning and decision making- Natural language processing (NLP) in human-robot interaction- AI in autonomous systems.

APPLICATIONS OF ROBOTICS AND ARTIFICIAL INTELLIGENCE IN INDUSTRY

Manufacturing and Automation: Robotic assembly and welding- Material handling and logistics. Healthcare and Medical Robotic: Surgical robots- Rehabilitation and assistive robots. Service Robotics: Domestic robots- Professional service robots (cleaning, delivery). Emerging Applications: Agriculture- Space exploration- Disaster response.

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1: Apply fundamental concepts of robotics and artificial intelligence to analyze and evaluate different types of robotic systems and their components.	**Apply**
CO2: Apply the principles of forward and inverse kinematics along with image processing techniques to solve problems related to the motion, positioning, and visual data interpretation of robotic arms.	**Apply**
CO3: Apply programming skills to develop and implement control algorithms for various types of robotic systems.	**Apply**
CO4: Apply machine learning algorithms to enable robots to learn from data and improve their performance over time.	**Apply**
CO5: Apply robotic automation techniques to optimize manufacturing processes and improve productivity.	**Apply**

Reference Book(s):

1. K.S. Fu, R.C. Gonzalez, and C.S.G. Lee “Robotics: Control, Sensing, Vision, and Intelligence”. McGraw-Hill, 1st Edition, 1987.
2. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar “Robot Modeling and Control”. Wiley, 1st Edition,2005.
3. John J. Craig “Introduction to Robotics: Mechanics and Control”. Pearson, 4th Edition,2017.
4. Stuart Russell and Peter Norvig “Artificial Intelligence: A Modern Approach”. Pearson, 4th Edition, 2020.
5. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, and Nicholas G. Odrey “Industrial Robotics: Technology, Programming, and Applications”. McGraw-Hill, 2nd Edition,2012.

Course Code: 24CCE005		Course Title: ADDITIVE MANUFACTURING	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to:

1. Apply the principle, methods, possibilities and limitations as well as environmental effect
2. Design a component based on additive manufacturing environment
3. Know about the different materials used for additive manufacturing systems

MODULE I **22 Hours**

INTRODUCTION

Overview – Need - Development of Additive Manufacturing Technology -Principle –AM Process Chain- Classification –Rapid Prototyping- Rapid Tooling – Rapid Manufacturing – Applications- Benefits –Case studies.

DESIGN FOR ADDITIVE MANUFACTURING

Design tools: Data processing - CAD model preparation – Part orientation and support structure generation — Model slicing –Tool path generation- Design for Additive Manufacturing: Concepts and objectives- AM unique capabilities – DFAM for part quality improvement- Customised design and fabrication for medical applications.

MATERIALS AND APPLICATIONS

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

MODULE II **23 Hours**

VAT POLYMERIZATION, MATERIAL EXTRUSION & SHEET LAMINATION TECHNOLOGIES

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

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

Powder Bed Fusion: Selective Laser Sintering (SLS): Principles - Process - Indirect and Direct SLS - Powder Structure -Materials - Surface Deviation and Accuracy – Capabilities, Applications. Electron Beam Melting (EBM): Principles — Processes — Materials — Capabilities - Limitations and Applications. Binder Jetting: Three dimensional Printing (3DP): Principles - Process - Physics of 3DP - Process — Materials - Capabilities - Limitations - Applications. Material Jetting: Multi Jet Modelling (MJM) - Principles - Process - Materials - Capabilities and Application. Direct Energy Deposition: Laser Engineered Net Shaping (LENS): Processes- Materials- Capabilities

- Limitations and Applications. Hybrid Additive Manufacturing – Need - Principles - Part Quality and Process Efficiency. Wire Arc Additive Manufacturing (WAAM) Processes-Materials-Capabilities - Limitations and Applications. Case Studies.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Apply the importance of DfAM in improving the quality of fabricated parts and understand the guidelines of DfAM	**Apply**
CO2: Apply the properties and characteristics of materials used in AM and explore the applications in various fields.	**Apply**
CO3: Apply the working principles and applications of vat polymerization, material extrusion and sheet lamination processes with case studies.	**Apply**
CO4: Apply the working principles of powder bed fusion, jetting, direct energy deposition and hybrid processes	**Apply**

Reference Book(s):

R1. Ian Gibson, David W. Rosen and Brent Stucker, “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing” Springer - New York, USA, 3rd Edition, 2021.

R2. A Practical Guide to Design for Additive Manufacturing, Diegel, Olaf, Axel Nordin, and Damien Motte, Springer, 2020.

R3. Ben Redwood, Brian Garret, Filemon Schoffer, and Tony Fadel, “The 3D Printing Handbook: Technologies, Design and Applications”, 3D Hubs B.V., Netherland, 2017.

R4. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 1°t Edition, 2019 FL, USA.

Course Code: 24CCE006		Course Title: EXPERIMENTAL METHODS AND ANALYSIS	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to

Impart knowledge on the experimental methods, experimental data analysis and concepts of temperature and thermal measurement, data acquisition and processing.

MODULE I **22 Hours**

Basic Concepts

Introduction — Definition of Terms — Calibration- Standards — Dimension and Units- The Generalized Measurements System- Basic concepts in Dynamic Measurements — System Response- Distortion- Impedance Matching- Experiment Planning.

Analysis of Experimental Data

Introduction — Causes And Types of Experimental Errors- Error Analysis on A Commonsense Basis — Uncertainty Analysis- Evaluation of Uncertainties For A Complicated Data Reduction- Statistical Analysis of Experimental Data — Probability Distributions- The Gaussian Or Normal Error Distribution-Comparison of Data With Normal Distribution-The Chi-Square Test of Goodness of Fit- Method of Least Squares – The Correlation Coefficient- Multivariable Regression- Standard Deviation of The Mean- Students-T-Distribution-Graphical Analysis And Curve Fitting-Choice of Graph Formats-General Consideration in Data Analysis.

MODULE II **23 Hours**

Measurement of Temperature

Introduction Temperature Scales-The Ideal- Gas Thermometer-Temperature Measurements by Mechanical Effects- Temperature Measurements By Electrical Effects- Temperature Measurements By Radiation- Effect of Heat Transfer on Temperature Measurements — Transient Response of Thermal System- Thermocouple Compensation. Temperature Measurement in High speed flow.

Thermal and Transport- Property Measurements

Introduction-Thermal Conductivity Measurements-Thermal Conductivity of Liquids and Gases- Measurements of Viscosity-Gas Diffusion-Calorimetry-Convection Heat-Transfer- Measurements- Heat-Flux Meters-Ph Measurements.

Data Acquisition and Processing

Introduction- The General Data Acquisition System- Signal Conditioning Revisited-Data Transmission-Analog-To-Digital And Digital-To-Analog Conversion-Data Storage And Display-The Program as A Substitute For Wired Logic.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Apply the basics on the Experimental methods and experimental data analysis.	**Apply**
CO2: Apply the concepts of Temperature measurement, Thermal and transport property measurements.	**Apply**
CO3: Apply the data acquisition and processing.	**Apply**

Reference Book(s):

R1. Holman J P, “Experimental Methods for Engineers”, McGraw-Hill Education private limited, New Delhi, 2017.

R2. Principles of Experimental Research Course Packet, F&S printing Department, 2011.

R3. Bevington R P, Robinson D K, “Data Reduction and Error Analysis for the Physical Sciences”, McGraw Hill, 2014.

R4. Wheeler J A, Ganji A R, “Introduction to Engineering Experimentation”, Prentice Hall, 2015.

<table>
<tr><td colspan="2">Course Code: 24CCE007</td><td colspan="2">Course Title: PRODUCT LIFE CYCLE MANAGEMENT</td></tr>
<tr><td colspan="2">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 0</td><td>Credits: 3</td><td>Total Contact Hours: 45</td><td>Max Marks:100</td></tr>
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Course Objectives:

The course is intended to impart the latest knowledge, strategies, practices, and applications in the PLM domain, develop strategies for successful PLM implementation aligned with corporate objectives, provide an in-depth understanding of various PLM applications and solutions, build a conceptual foundation for integrating PLM with ERP, QMS, and MES, and explore use case scenarios through diverse customer case studies

MODULE I **22 Hours**

OVERVIEW OF PLM

Overview, Need, Benefits, Concept of Product Life Cycle, Components / Elements of PLM, Emergence and Significance of PLM, organization structure ,PLM implementation cases in various industry verticals , case study on the implementation of real time product in PLM.

PLM STRATEGY AND PRODUCT SOLUTIONS

Company's PLM vision, PLM Strategy- Preparing for the PLM strategy, Developing a PLM strategy, Strategy identification and selection, PLM business goals.

Management- Project Management, schedule management, Structure management and variant management. Different phases of product lifecycle and corresponding technologies, Enterprise information, Product Structure & Configuration, Bill of Material (E-BOM, M-BOM, S-BOM), Requirement, Portfolio.

23 Hours

MODULE II

INTRODUCTION TO INTEGRATION WITH ERP, QMS, MES

Introduction to ERP (Enterprise Resource Planning), QMS (Quality Management System), MES (Manufacturing Execution System) and Concepts involved in integration of PLM with enterprise systems like ERP, QMS and MES, Workflow Management system- three phases, handlers.

CUSTOMER CASE STUDIES

Impact and Challenges faced while implementing a successful PLM strategy -.Rolls Royce, Nissan Motor, Sunseeker International, Dr. Martens, Ben Ainslie Racing, Xtrac, Kesslers International, Weatherford International.

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1: Apply PLM Strategies and various PLM solutions and concepts like projects, schedule, structure , variant management ,product structures, bill of materials, and requisite tasks in PLM.	**Apply**
CO2: Apply the concepts involved in integration of PLM with ERP, QMS ,MES and workflow.	**Apply**
CO3: Analyze the various customer use cases from the successful Implementation.	**Analyze**

Reference Book(s):

R1. John Stark, "Product Lifecycle Management: Volume 1: 21st Century Paradigm for Product Realisation", Springer International Publishing Switzerland,3rd edition, 2015.

R2. Grieves Michael, "Product Lifecycle Management- Driving the Next Generation of Lean Thinking", McGraw-Hill, 2006.

R3. Wang, Lihui; Nee, Andrew Y.C. (Eds.) "Collaborative Design and Planning for Digital Manufacturing", Springer, 2009.

R4. Kari Ulrich and Steven D. Eppinger, "Product Design & Development", McGraw Hill International Edns, 1999.

R5. Elangovan, U., "Product Lifecycle Management (PLM)". Boca Raton, CRC Press,

Course Code: 24CCE008	Course Title: MECHANICS OF COMPOSITE MATERIALS		
Course Category: Professional Elective	Course Level: Mastery		
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks:100

COURSE OBJECTIVES

Understand the fundamentals of composite material strength and the analysis of fiber-reinforced laminate design for different combinations of plies with various fiber orientations. Additionally, study the thermo-mechanical behavior and residual stresses in laminates during processing, and implement Classical Laminate Theory (CLT) to analyze residual stresses in isotropic layered structures, such as electronic chips.

MODULE I **22 Hours**

INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS & MANUFACTURING

Definition –Need – General Characteristics, Applications. Fibers – Glass, Carbon, Ceramic and Aramid fibers. Matrices – Polymer, Graphite, Ceramic and Metal Matrices – Characteristics of fibers and matrices. Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Typical Commercial material properties, Rule of Mixtures. Generally Orthotropic Lamina –Transformation Matrix, Transformed Stiffness. Manufacturing: Bag Moulding Compression Moulding – Pultrusion – Filament Winding – Other Manufacturing Processes.

FLAT PLATE LAMINATE CONSTITUTE EQUATIONS

Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations — Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.

MODULE II **23 Hours**

LAMINA STRENGTH ANALYSIS

Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill's Criterion for Anisotropic materials. Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure.

THERMAL ANALYSIS

Assumption of Constant C.T.E’s. Modification of Hooke’s Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T.E’s. C.T.E’s for special Laminate Configurations — Unidirectional, Off-axis, Symmetric Balanced Laminates, Zero C.T.E laminates, Thermally Quasi-Isotropic Laminates.

ANALYSIS OF LAMINATED FLAT PLATES

Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations — Natural Frequencies

Course Outcomes **At the end of this course, students will be able to:**	**Cognitive Level**
CO1: Apply constitutive equations of composite materials and understand mechanical behavior at micro and macro levels.	Apply
CO2: Analyze laminated composite using laminate constitute equations.	Apply
CO3: Analyze the stress strain relationship of orthotropic & anisotropic materials and mechanical and thermal properties of laminated flat plates	Apply

Reference(s):

R1.Issac M. Daniel and Ori Ishai, “Engineering Mechanics of Composite Materials”, Oxford University Press-2006, Second Indian Edition - 2006

R2.Mallick, P.K., Fiber, ”Reinforced Composites: Materials, Manufacturing and Design”, CRC Press, 2007.

R3. Bhagwan D. Agarwal, Lawrence J. Broutman, K. Chandrashekhara · “Analysis and Performance of Fiber Composites”, John Wiley and Sons, New York, 2017.

R4.Mallick, P.K. and Newman, S., (edition), “Composite Materials Technology: Processes and Properties”, Hansen Publisher, Munish, 1990.

R5.Gibson, R.F., "Principles of Composite Material Mechanics", Second Edition, McGraw-Hill, CRC press in progress, 2007.

<table>
<tr><td colspan="2">Course Code: 24CCE009</td><td colspan="2">Course Title: OPTIMIZATION TECHNIQUES IN ENGINEERING</td></tr>
<tr><td colspan="2">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P(Hours/Week) 3: 0: 0</td><td>Credits: 3</td><td>Total Contact Hours: 45</td><td>Max Marks:100</td></tr>
</table>

Course Objectives:

The course is intended to describe the various optimization techniques used in engineering.

MODULE I **23 Hours**

OVERVIEW OF OPTIMIZATION

Introduction to Optimization: Application of Optimization in Engineering –Optimization problem – Optimal Problem formulation – Classification of Optimization problem. Optimum design concepts: Definition of Global and Local optima – Optimality criteria.

LINEAR PROGRAMMING

Linear programming methods for optimum design – Standard LP problems, Simplex, Dual, Dual-Simplex methods- Application of LPP models in design and manufacturing.

Transportation Problems- North West Corner rule, Vogel's Approximation method- - Assignment problems- Optimal solution using Hungarian Method for Balanced and Unbalanced Problems - Traveling Salesman problem.

MODULE II **22 Hours**

Networking models- PERT, CPM

Uncontrained Optimization- Fibonaci Search Method-Steepest Decent Method.

Constrained Optimization- Maxima- Minima, Lagrange Multiplier, Karush-Khun Tucker Method

Numerical optimization techniques: line search methods, gradient methods, Newton's method

Evolutionary algorithms for optimization and search , Ant Colony Optimization, Simulated Annealing, Neural Network Optimization, Fuzzy Logic Optimization.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Apply the concept of Linear programming, transportation and assignment problems.	**Apply**
CO2: Apply the methods of Un constrained and constraine Optimizations	**Apply**
CO3: Apply the concept of evolutionary algorithms of optimization.	**Apply**

Reference Book(s):

R1. KantiSwarup, Gupta, P.K. and Manmohan (2014): Operations Research, 13th Edition, Sultan Chand and Sons

R2. J.K.Sharma, Operations Research:Thoery and applications,5th edition, Macmillan India Ltd.

R3. Taha, H. A. (2019): Operations Research: An Introduction, 8th Edition, Prentice Hall of India.

R4. R. Ravindran, D. T. Philips and J. J. Solberg, Operations Research: Principles and Practice, 2 nd ed., John Wiley & Sons, 2007.

Course Code:24CCE011	Course Title: COMPUTATIONAL FLUID DYNAMICS		
Course Category: Professional Elective	Course Level: Mastery		
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course objectives

The course aims to explain the governing equations for fluid flow and solve the conduction, convection heat transfer using finite difference and to enable the students to understand the concept of turbulence modeling

Module I **23 Hours**

Governing Differential Equation and Finite Difference method: Continuity equation, momentum equation, energy equation, classification, initial and boundary conditions, finite difference method -central, forward and backward difference, uniform and non-uniform grids, numerical errors.

Conduction Heat Transfer: Steady one-dimensional conduction, two and three-dimensional steady state problems, transient one-dimensional problem, two-dimensional transient problems

Convection Heat Transfer: Steady one-dimensional and two-dimensional convection – diffusion, unsteady one-dimensional convection – diffusion, unsteady two-dimensional convection – diffusion

Module II **22 Hours**

Incompressible Fluid Flow: Governing equations, stream function – vorticity method, determination of pressure for viscous flow, SIMPLE procedure of Patankar and Spalding, computation of boundary layer flow.

Turbulence Models : Algebraic models – one equation model, K – Ɛ models, standard and high and low Reynolds number models, prediction of fluid flow and heat transfer using standard code.

Course outcomes:

CO1: Explain the discretization of governing equations using finite difference method.	**Understand**
CO2: Solve the conduction and convection heat transfer using finite difference method.	**Apply**
CO3: Solve incompressible viscous flow problems using vorticity method and SIMPLE algorithm	**Apply**
CO4: Calculate the fluid flow and heat transfer properties using turbulence modeling.	**Apply**

Reference Book(s):

1. Anderson D.A., Tannehil J.C, Pletcher R.H, Computational Fluid Mechanics & Heat Transfer,Hemisphere Publishing Corporation, New York, 2004.
2. John D. Anderson, Computational Fluid Dynamics: The Basics with Applications, First Edition, McGraw-Hill Education, 2012
3. Murlidhar.K.,Sunderrajan.T, Computational Fluid Mechanics and Heat Transfer, Narosa Publishing House, 2008.
4. Klaus A. Hofmann, Steve T. Chiang, Computational Fluid Dynamics, Fourth Edition,Engineering Education System, 2000.

Web References:

1. https://www.cfd-online.com/Links/
2. https://www.simscale.com/forum/t/a-collection-of-cfd-resources/70650

Course Code:24CCE012	**Course Title: FLEXIBLE COMPETITIVE MANUFACTURING SYSTEM**		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P: 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Course Objectives

To emphasize the knowledge on the quality improvement, automation, and advanced manufacturing techniques to create the highest-calibre products quickly, efficiently, inexpensively, and in synchronization with the marketing, sales, and customer service of the company.

MODULE I **23 hrs**

MANUFACTURING IN A COMPETITIVE ENVIRONMENT

Automation of manufacturing process - Numerical control - Adaptive control - material handling and movement - Industrial robots - Sensor technology - flexible, fixturing - Design for assembly, disassembly and service.

GROUP TECHNOLOGY

Part families - classification and coding - Production flow analysis - Machine cell design - Benefits.

FLEXIBLE MANUFACTURING SYSTEMS

Introduction - Components of FMS - Application workstations - Computer control and functions - Planning, scheduling and control of FMS - Scheduling - Knowledge based scheduling - Hierarchy of computer control - Supervisory computer.

MODULE II **23 hrs**

COMPUTER SOFTWARE, SIMULATION AND DATABASE OF FMS **9 Hours**

System issues - Types of software - specification and selection - Trends - Application of simulation - software - Manufacturing data systems - data flow - CAD/CAM considerations - Planning FMS database.

JUST IN TIME

Characteristics of JIT - Pull method - quality -small lot sizes - work station loads - close supplier ties - flexible work force - line flow strategy - preventive maintenance - Kanban system - strategic implications - implementation issues - MRD JIT - Lean manufacture.

Course Outcomes	**Cognitive**

At the end of this course, students will be able to:		Level
CO1:	Select a suitable manufacturing technique in competitive environment for future industries.	**Apply**
CO2:	Analyze the concepts of group technology in FMS for machine cell design.	**Analyze**
CO3:	Analyze the software, database related to FMS for manufacturing data systems and JUST IN TIME concept for effective manufacturing	**Analyze**

Text Book(s):

1. Groover M.P., “Automation, Production Systems and Computer Integrated Manufacturing ", Prentice-Hall of India Pvt. Ltd., New Delhi, 2009.
2. Kalpakjian, " Manufacturing Engineering and Technology ",Prentice Hall; 6 edition , 2009

Reference Book(s):

1. Jha, N.K. "Handbook of Flexible Manufacturing Systems ", Academic Press Inc., 2000.
2. Taiichi Ohno, Toyota, " Production System Beyond Large-Scale production", Productivity Press (India) Pvt. Ltd., 1992
3. Pascal Dennis, “Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System”, (Second edition), Productivity Press, New York, 2007.

Web References:

1. https://nptel.ac.in/courses/112107143/36
2. https://nptel.ac.in/courses/112104228/31
3. https://nptel.ac.in/courses/110106044/28

Course Code: 24CCE013	Course Title: PRODUCT DATA MANAGEMENT		
Course Category: Professional Elective	Course Level: Mastery		
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to identify key components of Product Data Management (PDM) for developing simple projects throughout the product lifecycle, and integrate Data Management Systems for handling FEA data.

MODULE I **22 Hours**

INTRODUCTION & COMPONENTS OF PDM

Introduction to PDM-present market constraints-need for collaboration - internet and developments in server-client computing.

Components of a typical PDM setup-hardware and software-document management-creation and viewing of documents-creating parts-versions and version control of parts and documents-case studies.

CONFIGURATION MANAGEMENT

Base lines-product structure-configuration management-case studies.

MODULE II **23 Hours**

PROJECTS AND ROLES

Creation of projects and roles-life cycle of a product- life cycle management-automating information flow- work flows- creation of work flow templates -life cycle-work flow integration-case studies. Report writing- Types of report, guidelines to review report, typing instructions, oral presentation.

CHANGE MANAGEMENT

Change issue- change request- change investigation- change proposal - change activity – case studies.

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1: Select the components of PDM to develop a model.	Apply
CO2: Develop the simple projects in life cycle of a product.	Apply
CO3: Apply Data Management Systems in FEA data.	Apply

Reference(s):

R1. Panneerselvam, R.,Research Methodology, Prentice-Hall of India, New Delhi, 2014.

R2. Kumar, Ranjit, , "Research Methodology: A Step by Step Guide for beginners", London Sage: Publications, 2023.

R3. Halbert, "Resisting Intellectual Property", Taylor & Francis Publications,2007.

R4. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in NewTechnological Age", Clause 8 Publishing,2016.

R5. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand Publications, 2008.

Course Code: 24CCE014		Course Title: METROLOGY AND NON-DESTRUCTIVE TESTING	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course on Metrology and Non-Destructive Testing aims to provide students with the knowledge and skills for accurate measurement and quality assurance in engineering processes. It includes the use of non-destructive testing techniques to assess the properties of materials and components without causing harm, ensuring their reliability and safety across various

MODULE I **22 Hours**

INTRODUCTION TO METROLOGY

Introduction to metrology: Definition, types, need of inspection, terminologies, methods of measurement, selection of instruments, Errors in measurement , Standards, Standardization, Standardizing Organizations, Instruments for Linear Measurements (types, principles, applications, limitations and errors), Instruments for Angular Measurements, types, principles, applications, imitations and errors, Instruments for Surface Measurements , types, principles, applications, limitations and errors, Comparators, Interferometry.

GEOMETRIC DIMENSIONING AND TOLERANCING

Limits fits and tolerances: Interchangeability, selective assembly, limits, fit and tolerances, limit gauging, design of limit gauges, computer aided tolerancing -Measurement of straightness, flatness, squareness, parallelism, roundness and cylindricity, non-contact profiling systems, Gauges and its classification.

MODULE II **23 Hours**

NON-DESTRUCTIVE TESTING

Scope and limitations of NDT, Visual examination methods, Different visual examination aids-Liquid Penetrant Testing Principle, Characteristics of liquid penetrants - different washable systems - Developers - applications — Introduction to Magnetic Particle Testing Process -Methods of production of magnetic fields - Principles of operation of magnetic particle test - Applications - Advantages and limitations. Principle of Radiographic testing process, Sources of ray-x-ray production - properties of d and x rays - film characteristics - exposure charts - contrasts - operational characteristics of x ray equipment - applications. Introduction to Ultrasonic testing process Basic principles of sound propagation, types of sound waves, Principle of UT, methods of

UT, their advantages and limitations, Piezoelectric Material, Various types of transducers/probe, Calibration methods, use of standard blocks, technique for normal beam inspection, flaw characterization technique, defects in welded products by UT, Thickness determination by ultrasonic method, Study of A, B and C scan presentations, advantage, limitations acoustic emission testing — principles of AET and techniques, Eddy current testing: Principle, instrument, techniques, sensitivity, application.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Compare the critical engineering parameters measured by the measuring instruments using GD&T concept to describe the condition of the working machinery or a part.	**Apply**
CO2: Identify the surface flaws in all porous materials using the process of liquid penetrant and magnetic particle testing.	**Apply**
CO3: Identify the internal defects utilizing either X-rays or gamma rays to verify the internal structure and integrity of the specimen.	**Apply**
CO4: Apply Ultrasonic and Acoustic Emission method of non-destructive testing using different scan techniques to identify the defect in the product manufactured.	**Apply**
CO5: Apply the principles, instrumentation techniques and sensitivity of Eddy current testing in practical applications.	**Apply**

Reference Book(s):

R1. Jain, R.K. “Engineering Metrology ", Khanna Publishers, 2009, ISBN: 978-81-7409-153-X.

R2. The Metrology Hand book- Jay. L.Bucher (ed), American Society for Quality, 2004.

R3. C. Hellier, Handbook of Nondestructive Evaluation, McGraw-Hill Professional, 1st edition (2001).

R4. N. A. Tracy, P. O. Moore, Non-Destructive Testing Handbook: Liquid Penetrant Testing. 2, American Society for Nondestructive Testing, 3rd edition (1999).

R5. Barry Hull and Vernon John, " Non-Destructive Testing ", MacMillan, 1988.

Course Code: 24CCE015	Course Title: COMPUTER AIDED PROCESS PLANNING		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Explains process planning and product planning and GT.
2. Explain geometric modeling techniques, tolerance, and GT.
3. Choose suitable process planning technique for the given part.
4. Explain different computer aided process planning systems.
5. Explain integrated process planning system, selection process, and report generation.

MODULE I **23 Hours**

INTRODUCTION

Introduction to Process Planning and Production Planning — Process Planning in the Manufacturing cycle - Process Planning and Concurrent Engineering, CAPP, Group Technology.

PART DESIGN REPRESENTATION

Design Drafting - Dimensioning - Conventional tolerance - Geometric tolerance - CAD - input / output devices - topology - Geometric transformation - Perspective transformation - Data structure - Geometric modeling for process planning - GT layout, GT- coding - The optiz system - The MICLASS system-CODE system.

PROCESS ENGINEERING

Experienced, based planning - Decision table and decision trees - Process capability analysis – Process boundaries – Process parameters – Process optimization.

MODULE II **23 Hours**

PROCESS PLANNING

Process Planning - Variant process planning - Generative approach - Forward and Backward planning, Input format, AI

COMPUTER AIDED PROCESS PLANNING SYSTEMS

Logical Design of a Process Planning - Implementation considerations -manufacturing system components, production Volume, No. of production families - CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP.

AN INTEGRATED PROCESS PLANNING SYSTEMS

Totally integrated process planning systems - An Overview – TIPPS Design philosophy- CAD Interface, Modulus structure – Interactive surface identification, Process knowledge- Description language - Data Structure, operation - Input and Display of CAD model- surface identification - select process- select process parameters- Report Generation- Testing results, Expert process planning.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Apply process planning, product planning and Group technology for manufacturing process.	Apply
CO2: Apply the part design representation and Group technology coding system	Apply
CO3: Choose suitable process planning technique for the given part	Evaluate

Reference Book(s):

R1. Gideon Halevi and Roland D. Weill, " Principles of Process Planning ", A logical approach, Chapman & Hall, 1997

R2. Tien-Chien Chang, Richard A.Wysk, "An Introduction to automated process planning systems ", Prentice Hall, 1985

R3. Chang, T.C., " An Expert Process Planning System ", Prentice Hall, 1990

R4. Nanua Singh, "Systems Approach to Computer Integrated Design and Manufacturing ", John Wiley & Sons, 1996.

R5. Rao,P.N " Computer Aided Manufacturing ", Tata McGraw Hill Publishing Co., 2001

<table>
<tr><td colspan="2">Course Code: 24CCE016</td><td colspan="2">Course Title: MATERIAL TESTING AND CHARACTERIZATION</td></tr>
<tr><td colspan="2">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 0</td><td>Credits:
3</td><td>Total Contact Hours: 45</td><td>Max Marks:100</td></tr>
</table>

Course Objectives:

The course is intended to

To impart knowledge on the principles of optical and electron microscopy, X-ray diffraction and various spectroscopic techniques.

MODULE I **22 Hours**

Optical Microscopy

Optical microscope - Basic principles and components, Different examination modes (Bright field illumination, Oblique illumination, Dark field illumination, Phase contrast, Polarised light, Hot stage, Interference techniques), Stereomicroscopy, Photomicroscopy, Colour metallography, Specimen preparation, Applications.

Electron Microscopy

Interaction of electrons with solids, Scanning electron microscopy Transmission electron microscopy and specimen preparation techniques, Scanning transmission electron microscopy, Energy dispersive spectroscopy, Wavelength dispersive spectroscopy.

MODULE II **23 Hours**

Diffraction Methods

Fundamental crystallography, Generation and detection of X-rays, Diffraction of X-rays, X-ray diffraction techniques, Electron diffraction.

Surface Analysis

Atomic force microscopy, scanning tunneling microscopy, X-ray photoelectron spectroscopy. Spectroscopy: Atomic absorption spectroscopy, UV/Visible spectroscopy, Fourier transforms infrared spectroscopy, Raman spectroscopy.

Thermal Analysis

Thermo gravimetric analysis, Differential thermal analysis, Differential Scanning calorimetry, Thermo mechanical analysis and dilatometry.

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1: Apply appropriate characterization techniques for microstructure examination at different magnification level and use them to understand the microstructure of various materials.	**Apply**
CO2: Apply appropriate spectroscopic technique to measure vibrational / electronic transitions to estimate parameters like energy band gap, elemental concentration, etc.	**Apply**
CO3: Apply thermal analysis techniques to determine thermal stability of and thermodynamic transitions of the specimen.	**Apply**

Reference Book(s):

R1. Li, Lin, Ashok Kumar Materials Characterization Techniques Sam Zhang; CRC Press, (2008).

R2. Cullity, B.D., and Stock, R.S., "Elements of X-Ray Diffraction", Prentice-Hall, (2001).

R3. Tyagi, A.K., Roy, Mainak, Kulshreshtha, S.K., and Banerjee, S., Advanced Techniques for Materials Characterization, Materials Science Foundations (monograph series), Volumes 49 — 51, (2009).