VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

Scheme of Teaching and Examination – 2018-19

M.Tech In Tool Engineering (MTE)

Outcome Based Education(OBE) and Choice Based Credit System (CBCS)

I SEMESTER

Sl. No	Course	Course Code	CourseTitle	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18MTE11	Applied Mathematics	04	--	03	40	60	100	4
2	PCC	18MTE12	Finite Element Method	04	--	03	40	60	100	4
3	PCC	18MTE13	Press Tool Design	04	--	03	40	60	100	4
4	PCC	18MTE14	Cutting Tool Theory and Design	04	--	03	40	60	100	4
5	PCC	18MTE15	Gauges and Measurements	04	--	03	40	60	100	4
6	PCC	18MTEL16	Manufacturing Engineering Lab-1	-	04	03	40	60	100	2
7	PCC	18RMI17	Research Methodology and IPR	02	--	03	40	60	100	2
			TOTAL	**22**	**04**	**21**	**280**	**420**	**700**	**24**

Note: PCC: Professional core, PEC: Professional Elective.

Internship: All the students have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed credit shall be counted forthe same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as failed and have to complete during the subsequent University examination after satisfying the internship requirements.

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II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18MTE21	Plastic Processing	04	--	03	40	60	100	4
2	PCC	18MTE22	Jigs and Fixture Design	04	--	03	40	60	100	4
3	PCC	18MTE23	Die Casting and Die Design	04	--	03	40	60	100	4
4	PEC	18MTE24X	Professional elective 1	04	--	03	40	60	100	4
5	PEC	18MTE25X	Professional elective 2	04	--	03	40	60	100	4
6	PCC	18MTEL26	Manufacturing Engineering Lab-11	--	04	03	40	60	100	2
7	PCC	18MTE27	Technical Seminar	--	02	--	100	--	100	2
TOTAL				**20**	**06**	**18**	**340**	**360**	**700**	**24**

Note: PCC: Professional core, PEC: Professional Elective.

Professional Elective 1		**Professional Elective 2**	
Course Code under 18MTE24X	**Course title**	**Course Code under 18MTE25X**	**Course title**
18MTE241	Advanced Material Technology	18MTE251	Product Design Technology
18MTE242	Tooling for Manufacturing in Automation	18MTE252	Rapid prototyping
18MTE243	Testing of Materials	18MTE253	Non Traditional Machining

Note:

1. Technical Seminar: CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Participation in the seminar by all postgraduate students of the same and other semesters of the programme shall be mandatory.

The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill and Question and Answer session in the ratio 50:25:25.

2. Internship: All the students shall have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed credit shall be counted in the same semester.Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as failed and have to complete during the subsequent University examination after satisfying the internship requirements.

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III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18MTE31	Plastic Mould Design	04	--	03	40	60	100	4
2	PEC	18MTE32X	Professional elective3	04	--	03	40	60	100	4
3	PEC	18MTE33X	Professional elective 4	04	--	03	40	60	100	4
4	Project	18MTE34	Evaluation of Project phase -1	--	02	--	100	--	100	2
5	Intenship	18MTEI35	Internship	(Completed during the intervening vacation of I and II semesters and /or II and III semesters.)		03	40	60	100	6
TOTAL				12	02	12	**260**	**240**	**500**	**20**

Note: PCC: Professional core, PEC: Professional Elective.

Professional elective 3		Professional elective 4	
Course Code under 18MTE32X	**Course title**	**Course Code under 18MTE33X**	**Course title**
18MTE321	**Advanced Moulding Techniques**	**18MTE331**	**Design for Manufacture**
18MTE322	**Nano Science and Nano Materials**	**18MTE332**	**Non Destructive Testing**
18MTE323	**Material Flow Analysis**	**18MTE333**	**Computer Control of Manufacturing Systems**

Note:

1. Project Phase-1: Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE (University examination) shall be as per the University norms.

2. Internship: Those, who have not pursued /completed the internship shall be declared as failed and have to complete during subsequent University examinations after satisfying the internship requirements.

Internship SEE (University examination) shall be as per the University norms.

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IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
1	Project	18MTE41	Project work phase -2	--	04	03	40	60	100	20
			TOTAL	--	**04**	**03**	**40**	**60**	**100**	**20**

Note:

1. Project Phase-2:

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a Senior faculty of the department. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report subjected to plagiarism check, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

SYLLABUS
SEMESTER-I

APPLIED MATHEMATICS

Course Code : 18MTE11 | **CIE Marks : 40**
Contact Hours/Week : 04 | **SEE Marks : 60**
Total Hours: 50 | **Credits: 04**
Exam. Hours : 03

Course Objectives: Main objectives of the course are to enhance the knowledge of various methods in finding the roots of an algebraic, transcendental or simultaneous system of equations, PDE and also to evaluate integrals numerically with a greater accuracy. These concepts occur frequently in their subjects like finite element method and other design application oriented subjects

MODULE - 1

Approximations and round off errors:
Significant figures, accuracy and precision, error definitions, round off errors and truncation errors.
Solution of Algebraic and Transcendental equations:
Bisection method, False position method, Newton- Raphson method, Secant Method, Muller's method, Graeffe's Roots Squaring Method.
10 Hours

MODULE - 2

Solution of System of Linear Equations:
Cramer's Rule, Rank of the matrix, Solutions of linear system of equations: consistency of system of equations, types of solutions, solving by Gauss elimination method , Gauss Jordan method , LU decomposition method, Gauss Seidel method, Relaxation method. **10 Hours**

MODULE - 3

Partial Differential Equations
Solution of non-homogeneous PDE by direct integration, Solution of homogeneous PDE involving derivative with respect to one independent variable, Lagrange's linear PDE. Solution of PDE by the method of Separation of variable, **10 hours**

MODULE - 4

Eigen values and Eigen Vectors:
Eigen values and eigen vectors by using characteristic equation. Jacobi method for symmetric matrices, Givens method for symmetric matrices, Householder's method for symmetric matrices, Rutishauser method for arbitrary matrices, Power method, Inverse power method.
10 hours

MODULE -5

Numerical solution for Differential and Integral Equations
Solution of Ordinary differential equations: Euler's modified method, Runga Kutta 4th order method, Taylor‟s series method, Milne‟s Predictor-corrector method.
Solutions for Integral Equations:
Trapezoidal rule, Simpson‟s 1/3rd and 3/8th rule, and Weddle‟s Rule. **10 hours**

Course Outcomes:
At the end of the course, students will be able to:
1. Acquire the idea of significant figures, method of approximation of roots of equation.
2. Apply the knowledge of direct methods and iterative methods for solving system of linear equations up to required accuracy.
3. Solve PDE by various methods.
4. Understand direct and numerical methods for finding Eigen values and Eigen values.
5. Understand numerical methods for various root finding differential and integral equations.

Question Paper Pattern:
• The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
• The question paper will have ten full questions carrying equal marks.
• Each full question consisting of 20 marks.
• There will be two full questions (with a maximum of four sub questions) from each module.
• Each full question will have sub question covering all the topics under a module.
• The students will have to answer five full questions, selecting one full question from each module.

Text Books:
1. S.S.Sastry, Introductory Methods of Numerical Analysis, PHI, 2005.
2. B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, 44rd Ed., 2017.
3. M K Jain, S.R.K Iyengar, R K. Jain, Numerical methods for Scientific and engg computation, New Age International, 2003.
Reference Books:
1. Pervez Moin, Fundamentals of Engineering Numerical Analysis, Cambridge, 2010.
2. David. C. Lay, Linear Algebra and its applications, 3rd edition, Pearson Education, 2002.
3. Erwin Kreyszig ,"Advanced Engineering Mathematics", 10th Edition , Willely India, 2016.

FINITE ELEMENT METHOD

		Credits	: 4
Sub Code	**:18MTE12**	**CIE Marks**	**:40**
Hrs/ Week	**:04**	**Exam Hours**	**:03**
Total Hrs.	**:50**	**SEE Marks**	**:60**

Course Objectives

1. Introduce the various aspects of FEM as applied to engineering problems .
2. Apply the fundamental concepts of mathematical methods and theory of elasticity to solve simple continuum mechanics problems.

Course Content:

MODULE -1

Introduction to Finite Element Method : General description of finite element method. Engineering applications of finite element method. Boundary conditions: homogeneous and nonhomogeneous. Principle of minimum Potential energy, Rayleigh Ritz method, Galerkin's method, Displacement method of finite element formulation. Convergence criteria, Discretisation process, Types of elements: 1D, 2D and 3D, Node numbering schemes. Strain displacement relations, Stress strain relations, Plain stress and Plain strain conditions, temperature effects

10 Hours

MODULE -2

Interpolation Models, 1D and 2D elements

Interpolation Models: Simplex, complex and multiplex elements, Interpolation polynomials in terms of local and global coordinates for 1D elements and CST element, Lagrange interpolation functions.

1D Elements: Solution for displacement, strain and stress for 1D bar and truss elements.

2D Elements: Solution for displacement, strain and stress for CST element.
elements.

10 Hours

MODULE -3

Analysis of Beams and Shafts

Analysis of Beams: Boundary conditions, Load vectors, Hermite shape functions, stiffness matrix based on Euler-Bernoulli beam theory, Numerical problems.

Analysis of Shafts: Finite element formulation of shafts, determination of stresses and twists in circular shafts.

10 Hours

MODULE -4

Heat Transfer and Fluid flow

Heat Transfer: Basic equations of heat transfer: Energy balance equation, Rate equation: conduction, convection, radiation, energy generated in solid, energy stored in solid, 1D finite element formulation using vibrational method, Problems with temperature gradient and heat fluxes, heat transfer in composite sections, straight fins.

Fluid flow: Flow through a porous medium, Flow through pipes of uniform and stepped sections.

10 Hours

MODULE -5

Axisymmetric elements and Dynamic considerations

Axisymmetric solid elements: Derivation of stiffness matrix of axisymmetric bodies with triangular elements, Numerical solution of axisymmetric triangular element(s) subjected to point loads

Dynamic Considerations: Formulation for point mass, Consistent element mass and Lumped mass matrices of one dimensional bar and truss elements

10 Hours

Text Books:

1. Chandrupatla T. R., "Finite Elements in engineering "- 2nd Edition, PHI, 2007.
2. Lakshminarayana H. V., "Finite Elements Analysis"– Procedures in Engineering, Universities Press, 2004
3. Rao S. S. "Finite Elements Method in Engineering"- 4th Edition, Elsevier, 2006

Reference Books:

1. P.Seshu, “Textbook of Finite Element Analysis”-PHI, 2004.
2. J.N.Reddy, “Finite Element Method”- McGraw -Hill In ternational Edition.
3. Bathe K. J. Finite Elements Procedures, PHI.
4. Cook R. D., et al. “Conceptsand Application of Fini te Elements Analysis”- 4 th Edition, Wiley & Sons, 2003.

Course Outcome: Students will be able to

1. Define the element properties such as shape function and stiffness matrix for the various elements.
2. Formulate element properties for 1D and 2D elements.
3. Develop skill to solve simple beam problems using the steps of FEM.

PRESS TOOL DESIGN

		Credits	**:4**
Sub Code	**:18MTE13**	**CIE Marks**	**: 40**
Hrs/ Week	**:04**	**Exam Hours**	**: 03**
Total Hrs.	**:50:**	**SEE Marks**	**: 60**

Course Objective:
The course makes students to learn intricacies involved in design of press tools and understand various tools used in practice.

Course Content:

MODULE -1

Introduction: Elements of press tools, classification of press, High speed presses, press brakes, shearing theory, cutting force, elements of press tool, clearance between punch and die, shut height and daylight, press tonnage calculation.
Strip Layout: Basic rules, economic layout, bridge size, calculation of plug point/center of pressure.

Press Tool Operations: Piercing, blanking, slitting, cropping, trimming, shaving, lancing, bending, curling, calibrating, drawing, Embossing, coining, flanging, fine blanking.

10 Hours

MODULE -2

Design of Press Tool Elements: Die plates, punches, punch holder plates, stripper plates, and calculation of stripping force, bolster plates, pilots, ejectors, shedders, material s ops, pillar, bush, slender punches, Stock guides, stock feeding device and die sets.
Types of Press Tools: Progressive tools, stage tools, compound tools, combination tools, cam actuated die, horn dies, sub press dies, inverted dies, bulging dies, levering dies, trimming dies, shaving dies, riveting dies, assembly dies, lamination dies. **Extrusion**: Forward, backward, combined extrusion, Modem metal forming techniques.

10 Hours

MODULE -3

Bending and Forming Dies: Theory of bending, development of bend, spring back, correcting spring back, bending tools, U - bending, V -bending, forming tools, bending on press brake,' bending force calculation.

10Hours

MODULE -4

Drawing: Theory of drawing, blank development, strain factor, calculation of number of stages of drawing, circular draw, rectangular draw, draw force calculation, lubrication. Defects and remedies, ironing.

10 Hours

MODULE -5

Preparation and Presentation of Typical Designs in the Form of Drawings for the Following

1. Piercing & blanking tool.
2. Progressive tool
3. Stage tool
4. Bending tool
5. Compound tool

10 Hours

Text Books:

1.D. Eugene Ostergaard," **Basic die design",** McGraw-Hill, 1963

2. J.R.Paquin, R.E Crowley **Die Design Fundaments,** Industrial Press Inc 2nd edition

3. Prakash.H Joshi **Press Tools** , Wheeler Publilisher

Reference Books:

1. DALLAS B. DANIEL, **"Progressive Dies",** Springer publication, 2005.

2. **Michigan** -SME Mining Engineering Handbook, 3rd Edition by peter darling, 2011.

3. **Die Design Hand Book** -SMITH A. DAVID.SME 3rd edition, 1990.

Course Outcome:

Students will be in a position to understand press tool types ,its design and press tool operations which makes them aware of type applications for which this knowledge can be applied.

CUTTING TOOL THEORY AND DESIGN

		Credits	: 4
Sub Code	:18MTE14	CIE Marks	:40
Hrs/ Week	:04	Exam Hours	:03
Total Hrs.	:50	SEE Marks	:60

Course Objective:

The course aims at giving exposure to students on metal cutting theory and its practice in industries.

Course Content:

MODULE -1

Mechanism of chip formation :Review of deformation mechanism, Fracture, Mechanism of yielding, overview of chip formation, concept of shearing strain. Mechanism of Metal Cutting, Force system during turning - velocity relationships – Force analysis in turning, milling, drilling etc.. **10 Hours**

MODULE -2

Measurement of cutting forces : dynamometer Tool wear mechanisms, types and causes of wear.
Turning Tools: Indexable Inserts, Chip breakers, ISO classification of inserts and tool holders.

10 Hours

MODULE -3

Milling Cutters: Standardization, geometry, Face Mills, Shoulder Mills, End Mills, Deep shoulder Mills, T-Slot cutters.

.

10 Hours

MODULE -4

Boring: Types of boring tool, Boring heads, Cartridges. REAMER Types of reamers, Geometry of flutes. TOOLS FOR CNC.
Drilling: Drills with index able inserts, Deep hole drills, carbide tipped drills, Core drills, Counter pores, and Counter sinks

10 Hours

MODULE -5

Design Exercise: Design of Single point tool, Drill, Form tools, Reamer.

10 Hours

Text Books:

1. **Metal Cutting and Tool Design,Dr**.B.J.Ranganath,Vikas Publishing House Pvt.Ltd.,New Delhi, Second Revised Edition,2009.
2. **Metal Cutting Theory and Cutting Tool Design**, Arshinov M I R Publications.
3. **Tool Design by Cyril Donaldson ,George H LeGain,V.G. Good, TATA Mc GRAW HILL**

Reference Books:

1. **All about Machine Tools**, Heinrich Gerling,New Age International (P) Limited, 2007**Production Technology**, HMT.
2. **Tool Design**, Herman W. Pollack, Prentice Hall PTR, 1988.
3. **Modelling of Metal Forming and Machining Processes**- Prakash M Dixit, Uday S dixit, Springer and verlag publication, 2008
4. **Machining Technology, Machine Tools and operations**- Helmi A. Youssef, Hassan El Hofy, Taylor and Francis group, 2008.

Course Outcome: Students will be able to understand mechanism of chip formation, measurement of cutting forces and its importance in cutting tool design, design of various cutting tools.

12

GAUGES AND MEASUREMENTS

Credits :4

Sub Code	:18MTE15	CIE Marks	:40
Hrs/ Week	:04	Exam Hours	:03
Total Hrs.	:50	SEE Marks	:60

Course Objective:
The course aims at making students learn about various gauges and measurement techniques.

Course Content:

Module-1

Introduction: Definition and objectives of metrology Linear measurement: neutral axis significance, imperial standard yard, international standard meter, airy points, Basel points, line, end & wave length standards, Slip Gages.
Angular Measurement: introduction, caparison with linear measurement sine bar: principle, types, advantages & limitations, uses, problems on sine bar angle blocks (angle gauges),practical uses, material, construction ,limitations problems on angle blocks.

10Hours

Module-2

Limits, Fits And Tolerance: Definitions, need of tolerance, types of tolerance, tolerance analysis (addition & subtraction of tolerances) interchangeability & selective assembly, representation of holes & shaft as per I.S. class & grade of tolerance,-difference between allowance & tolerance. **10 Hours**

Module-3

Fits: Definition, types of fits,(clearance, interference& transition), tolerance disposition chart, problems (calculation of fits) hole base system & shaft base system, procedure for solving on finding the hole & shaft tolerance upper & lower limits.

10Hours

Module-4

Design Of Gauges: Taylor's principle, MMC & LMC of hole & shaft types of gauges(plain, threaded, limit, single end , double end, progressive, position, etc) important points for gauge design, limitations of gauges,-problems on gauge design.

10 Hours

Module-5

Geometric Dimensioning &Tolerancing (Gd&T) Introduction, ANSI, ASME & ISO systems of GD&T, functional dimensioning, feature & feature of size, advantages & limitations, feature control frame, fourteen characteristic symbols, form controls, profile controls, orientation controls, location controls, runout controls, datum.

Design Exercise: Design of Plug Gauge, Ring Gauge, Snap Gauge, Indicator Gauge, Taper plate Gauge, Taper Plug Gauge, Thread Gauge and Position Gauge.

10 Hours

Text Books:

1. **Engineering Metrology** - R.K. Jain
2. **Westermann Tables for metal trade** – Juts scharkus, New age international Publishers
3. **Engineering Metrology,** K.J.Hume.

Reference Books:

1. **Geometric Dimensioning and Tolerancing**. A Self Study Workbook By Alex Krulikowski.
2. **Fundamentals of Geometric Dimensioning and Tolerancing.** ASME Y 14.5 M-1994.By Alex Krulikowski.
3. **Geometric Dimensioning and Tolerancing for Mechanical Design.** McGraw Hill

Course Outcome:

Students will be able to understand specification of limits, fits and tolerance ,design of gauges and its uses.

Manufacturing Engineering Lab 1

Credits :2

Subject Code:18MTEL 16	Hours/Week : 4
CIE Marks : 40	Exam Hours: 3
Total Hours : 48	SEE Marks : 60

Note:

1) These are independent laboratory exercises
2) A student may be given one or two problems stated herein
3) Student must submit a comprehensive report on the problem solved and give a Presentation on the same for Internal Evaluation
4) Any one of the exercises done from the following list has to be asked in the Examination for evaluation.

Exercises:

1. Optimizing machining time to produce mild steel components on a CNC turning Centre.
2. Characterize surface roughness of High carbon steel using a grinding machine.
3. To determine power required to machine a chosen component and evaluate suitability of the machine to manufacture the same.
4. To compare surface characteristics produced by conventional and CNC turning machines.
5. To Estimate the accuracy of taper produced on a shaft by grinding.
6. To measure cutting forces during machining of High carbon steel and optimize machining parameters.
7. To optimize a single point cutting tool for machining HC steel and to arrive at parameters like rake angle, relief angle, nose radius etc.
8. To study type of chips produced in machining Al/Composites materials/ HC alloy steels and to characterize chip thickness.
9. Construction of merchant circle diagram for turning operation of mild steel and to compute power requirement for turning operation.
10. Perform cutting/drilling/turning operations on mild steel/ high carbon steel/ composite material components and estimate power required for cutting/drilling/turning.

(Ex: for the hole, dia& feed values are provided, Student has to find the volume of metal removed and energy consumed)

11. Determine the true taper and actual taper mathematically and perform turning operations (roughing cuts) on lathe and estimate the tool life of tool on similar cuts at different speeds.

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SEMESTER - I

RESEARCH METHODOLOGY AND IPR
(Professional Core Course) and (Common to all M.Tech Programmes)

Course Code	18RMI17	CIE Marks	40
Number of Lecture Hours/Week	02	Exam Hours	03
Total Number of Lecture Hours	25	SEE Marks	60

Credits - 02

Course objectives:

- To give an overview of the research methodology and explain the technique of defining a research problem
- To explain the functions of the literature review in research.
- To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
- To explain various research designs and their characteristics.
- To explain the details of sampling designs, and also different methods of data collections.
- To explain the art of interpretation and the art of writing research reports.
- To explain various forms of the intellectual property, its relevance and business impact in the changing global business environment.
- To discuss leading International Instruments concerning Intellectual Property Rights.■

Module-1		**Teaching Hours**
Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India. ■		**05**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. **Reviewing the literature:** Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed. ■		**05**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs. **Design of Sample Surveys:** Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs. ■		**05**

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-4		
Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method. **Interpretation and Report Writing:** Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout		**05**

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SEMESTER - I

18RMI17RESEARCH METHODOLOGY AND IPR
(Professional Core Course) and (Common to all M.Tech Programmes)

Module-4 (continued)		**Teaching Hours**
Interpretation and Report Writing (continued): of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. ■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5		
Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO. ■		**05**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Discuss research methodology and the technique of defining a research problem
- Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
- Explain various research designs and their characteristics.
- Explain the art of interpretation and the art of writing research reports
- Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR.

Question paper pattern:

Examination will be conducted for 100 marks with question paper containing 10 full questions, each of 20 marks.

- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module
- Students will have to answer 5 full questions, selecting one full question from each module
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60

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SEMESTER - I

18RMI17 RESEARCH METHODOLOGY AND IPR
(Professional Core Course) and (Common to all M.Tech Programmes)

Textbooks

1	Research Methodology: Methods and Techniques	C.R. Kothari, Gaurav Garg	New Age International	4th Edition, 2018
2	ResearchMethodologyastep-by-stepguideforbeginners. (For the topic Reviewing the literature under module 2)	Ranjit Kumar	SAGE PublicationsLtd	3rd Edition, 2011
3	Study Material (For the topic Intellectual Property under module 5)	Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013		

Reference Books

1	Research Methods: the concise knowledge base	Trochim	Atomic Dog Publishing	2005
2	Conducting Research Literature Reviews: From the Internet to Paper	Fink A	Sage Publications	2009

SYLLABUS
SEMESTER-II

PLASTIC PROCESSING

			Credits :	**4**	
Sub Code	**:**	**18MTE21**	**CIE Marks**	**:**	**40**
Hrs/ Week	**:**	**04**	**Exam Hours**	**:**	**03**
Total Hrs.	**:**	**50**	**SEE Marks**	**:**	**60**

Course Objective:

The course aims at providing knowledge about various aspects of plastic processing.

Course Content:

Module-1

Plastic Processing: Basic principle of processing, shape and size, processing parameters, their effect and behavior, Rheology ideal fluids, and real polymers, Effects of melt behavior on processing and product performance.
Injection Moulding: Principles, process variables, moulding cycle, machinery used, parts and function, specification, construction and maintenance of injection moulding machine, start up and shut down procedure, cylinder, nozzles, interaction of moulding variables, press capacity, projected area, shot weight, concepts and their relationship to processing, trouble shooting in injection moulding, microprocessors controlled injection moulding machines. **10 Hours**

Module-2

Extrusion: Basic principles of extruders, and extrusion process, different types of extrudes i.e. barrel, screw, drive mechanics, head, constructional features of dies, sizing and haul-off equipment for extruders of mono filaments and tubes, blown film lines, wire and cable covering system, pipe profile extrusion, co-extrusion, process variables in extrusion like heating, temperature control, dies well, and melt fracture, spacing and orientation, treating, printing and sealing, quality of extruder products, fault, causes and remedy.
10 Hours

Module-3

Rotational Moulding: Basic principle, charge size, wall thickness, temperature control, fault causes,
Blow Moulding: Blow moulding process, processing parameter, materials used, hand operated and automatic blow moulding machine, extrusion blow moulding, moulding cycle, faults and remedies**.**
Thermo Forming: Basic principles, types of thermoforming, thermoforming moulds, processing parameters, faults and remedies. **10 Hours**

Module -4

Calendaring: Basic principle, process variable, end product properties and applications, secondary processing techniques like powder coating, casting, machining, and joining of plastics, metalizing, printing.

Compression and Transfer Moulding: Techniques, various types of compression moulds, machinery used, and commonmoulding faults and remedies. Transfer moulding, its advantage over compression moulding, equipment used, press Capacity ,integral mold,and auxiliary mould, moulding cycle, ram pressure, clamping pressure, faults and remedies.

10 Hours

Module -5

Processing of Engineering Plastics: precautions, and start up procedure, preheating, shutdown procedure, quality control, and waste management. Ram Extrusion of PTFE, Processing of reinforced plastics, like filament winding, Hand-lay-up, spray moulding, SMC, DMC, Centrifugal casting, pultrusion, resin transfer moulding.

10 Hours

TEXT BOOKS:

1. Plastic Processing Data Hand Book – Dominic V Rosat o P.E.
2. Modern Plastics Hand Book – Charles A Harper.
3. Injection Mould Design, Pye R.G. W. - New York-John Wiley & Sons 12th Ed.1989.

REFERENCE BOOKS:

1. Injection Moulding Theory & Practice, Rubin. J. Irvin, New York John Wiley & Sons.
2. Blow Moulding Hand Book, Rosato, New York-Oxford University-Hanser Publishers.
3. Principles of Rotational Moulding Process, Bruins.

Course Outcome:

Students will demonstrate their understanding of plastic processing, injection moulding, extrusion and thermo forming.

JIGS AND FIXTURES DESIGN

		Credits	: 4
Sub Code	: 18MTE22	CIE Marks	: 40
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	SEE Marks	: 60

Course Objective:
Course aims at making the students learn jigs and fixtures, clamping methods, guiding elements

Course Content:

Module-1

Introduction: Definition of Jigs and Fixtures, Difference between jigs and fixtures, Advantages, Steps for design. LOCATION Degree of freedom, 3-2-1 principles, Choice of location, redundant location, Diamond pin calculation, Locating methods and chip control.

10 Hours

Module-2

Locating Devices: Surface location, Rest blocks, pins, V-blocks, Equalizers, Profile locators, Vee locaters, Nesting locaters,Diamond Pins, adjustable Locaters.

Clamping Devices : Basic principles, cutting forces, Rigid clamping, wedge clamping, Cam clamping, quick action clamps, strap clamps, screw clamps, swing clamps, Toggle clamps, simultaneously acting clamps.

10 Hours

Module-3

Guiding Elements, Drill Bushings: Standard Drill Bushing types**,** Jig bushes Installation, Standards, Tool Setting gauges.

Indexing Jigs and Fixtures: Indexing methods, Linear, Rotary, Indexing jigs, Indexing fixtures. Assembly and Welding Fixture – Principles

10 Hours

Module-4

Design of Jigs and Fixture Bodies, other Elements, types of Jigs and Fixtures: Plate Jigs. Box Jigs ,Indexing Jigs, Millimg Fixtures, and Indexing –milling Fixtures, Turning Fixtures, Grinding Fixtures, Universal Jigs and Fixtures, welding fixtures, Broaching fixtures and assembly fixtures, Modular Fixturing

10 Hours

Module -5

Preparation and Presentation of typical designs in the form of drawings for the following

1. Drill Jig
2. Drilling and Reaming Jigs
3. Milling Fixtures
4. Indexing Jigs
5. Indexing Milling Fixtures.
6. Turning Fixtures

10 ours

Text Books

1 Jigs & Fixtures -JOSHI P .H.- New Delhi -Tata McGraw Hill Pub. Co. Ltd., 11th print 1999.

2 Jigs. & Fixtures & Gauges -BOYES E. WILLIAM-Michigan -SME 1st Ed. 1986.

3 Jigs and Fixture Design Manual- by Erik k Henriksen , Industrial Press Inc

REFERENCE BOOKS:

1. **An Introduction to Jig and Tool Design** -KEMPSTER M.H.A.- Bristol- ELBS 3rd Ed. 1974
2. .**Jigs and Fixture Hand book** by A.K.Goroshkin, MIR publisher Moscow
3. **Jigs and Fixture Hand book** by Carr Lane Mfg Com

Course Outcome:

Students demonstrate their knowledge in various jigs and fixtures,itsdesign,clamping methods and design and drawing of jigs and fixtures.

DIE CASTING AND DIE DESIGN

Credits	:	4			
Sub Code	:	18MTE23	CIE Marks	:	40
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	SEE Marks	:	60

Course Objective:
Students will learn about die casting machines and construction, design of various dies which helps them to analyse its suitability for variety of applications in industries.

Course Content:

Module-1

Introduction: Classification of Castings, Sand casting, Metal mould castings, Plastic moulds casting, Investment casting, Gravity die casting, Pressure die casting, Advantages of Die casting, Die casting process, vacuum casting. Die Casting Alloys Low fusion alloys, High fusion alloys, Properties.

10 Hours

Module-2

Die Casting Machines: History of die casting machines, Hot chamber machine, cold chamber machine, Horizontal machine, Vertical machine, Die locking, Toggle locking, Hydraulic locking, Injection systems, knock out pins and plates, ejector system furnaces, loading of metal into hot chamber.

10 Hours

Module-3

Feed System Gates, Runners, Taper tangent runner system, Precession layout, Spreader, shot sleeve, shot weight, PQ2 Diagram and calculations etc.

Die Construction: Cores, Cavities, pillars and bushes, ejectors, bolster plates.

Cooling System: Core cooling, Cavity cooling, cooling of shot sleeve, cooling of spreader, baffles, cooling calculations.

10 Hours

Module-4

Types of Dies: Single cavity dies, Multi cavity dies, combination dies, unit dies, trimming and finishing of components, Inspection of components, safety, SPC & visual control techniques.

Dies with side Cores: Construction, Actuation of side cores. Die casting, defects and remedies.

10 Hours

Module-5

Preparation and Presentation of Typical Designs in the Form of Drawings Following:

1.Cold chamber die casting dies.
2.Hot chamber die casting dies.
3.Single cavity die casting dies.
4.Multi cavity die-casting dies.
5.Dies with side cores and splits

10 Hours

Text Books:

1.Die Casting, Do Ehler H.A. New York -McGraw Hill Book Co-Inc. International Student Ed. 1951.
2.The Die Casting Book, Street. C. Arthur, Surrey, England -Portcullis Press Ltd., 2nd Ed. 1986.
3.Die Casting Dies Designing , E.A Herman, Society of Die casting Engineers

Reference Books:

1.Die Casting Process Control By EA Herman NADCA
2. High Pressure Die casting: by H. L. Harvill, Paul Roe Jordan,

Course Outcome:

Students will get an understanding of various types of dies, its construction and design. Students prepare drawings of various dies and demonstrate its design.

Professional Elective -I

ADVANCED MATERIALS TECHNOLOGY

			Credits	:	4
Sub Code	:	18MTE241	CIEMarks	:	40
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	SEE Marks	:	60

Course Objectives:
Students get an orientation into Newer Materials, Processing of Composites and analysis of composites, Nano Technology and Powder Metallurgy.

Course Content:

Module-1

STRUCTURE-PROPERTY RELATIONS Introduction, Atomic structure, atomic bonds, secondary bonds, crystal structure, Miller indices, packing efficiency, crystal defects, grain structure, elastic and plastic deformation in single crystals, dislocation theory, strain /work hardening, plastic deformation in polycrystalline metals, fracture of metals, cold working, re crystallization and hot working, grain growth.

NEWER MATERIALS: Introduction, plastics, molecular structure, isomers, polymerization, thermosetting and thermoplastic materials, properties and applications of plastics. Ceramics, nature and structure, fine ceramics, properties and applications of ceramics. Composite materials – classification, matrix and reinforcement materials, properties, rule of mixtures, longitudinal strength and modulus (iso strain model), transverse strength and modulus (iso stress model), applications of composites. **10 Hours**

Module-2

PROCESSING OF COMPOSITES: Liquid-state process, solid state process and in situ processes of MMC's. Slurry infiltration process, combined hot pressing and reaction bonding method, melt infiltration process, direct oxidation, isothermal chemical impregnation process and Sol-Gel and polymer pyrolysis of CMC's. Hand layup process, filament winding process, pultrusion process, pressure bag moulding, vacuum-bag moulding, autoclave moulding, injection moulding process and thermoforming process of PMC's.

METHODS OF ANALYSIS OF COMPOSITES: Micromechanics-Mechanics of material approach, elasticity approach to determine material properties. Macro mechanics- Stress-strain relations with respect to natural axis, arbitrary axis and determination of material properties. Experimental characterization of laminates and particulate composites.

10 Hours

Module-3

FAILURE ANALYSIS AND DESIGN OF COMPOSITES: Failure criterion for particulate and laminate composites. Design of laminated and particulate composites. Other mechanical design issues-Long term environmental effects, inter laminar stresses, impact resistance, fracture resistance and fatigue resistance.

NANO TECHNOLOGY: Introduction, concept of nanotechnology , nano science, nanomaterials (one, two and three dimensional), top down and bottom up constructions, fabrication of carbon nano tubes (CNT), nano material characterization – scanning probe microscopy, atomic force microscopy, scanning tunnelling microscopy, applications of nano technology.

10 Hours

Module-4

SURFACE TREATMENT: Introduction, Surface Engineering, Surface quality & integrity concepts, Mechanical treatment, Thermal spraying processes and applications, Vapour depositions processes and applications, Ion-treatment.

10 Hours

Module-5

POWDER METALLURGY: Introduction, Steps in powder metallurgy, Production of Powder, Characterization & Testing of Powders, Powder Conditioning, Powder Compaction, Sintering, Finishing operations, Applications of PM components.

10 Hours

TEXT BOOKS:

1. E.PaulDegarmo, J.T.Black, Ronald A Kohser. , **Materials and Processing in Manufacturing** 8th Edition – Prentice Hall India.
2. K.K.Chawla, **Composite materials** – Science & Engineering,.Springer.
3. A.K. Sinha, **Powder Metallurgy** 2nd Edition –. DhanpatRai Publications.
4. Dr. H.K.Shivanand, **Composite Materials** by. Asian Publication.
5. AUTAR K.KAW ,**Mechanics of composite materials**,Taylor and Francis group.

Reference Books:

1.Composite Materials, Science &Engg- Krishan K. Chawla, 2nd edition, Springer publicat1on.

2. ASM Handbook on Metal Casting - Vol .15, 9th edition, ASM publication

3. ASM Handbook on Powder Metallurgy -Vol 17, ASM publications

4. Nanotechnology – Basic Science and Emerging Technol ogies, -Mick Wilson, KamaliKannangara, Overseas Press India Private Limited, First Indian Edition 2005.

5. V.S.R Murthy, A.K.Jena, K.P.Gupta, G.S.Murthy**Structure and Properties of Engineering Materials**, , Tata McGraw Hill.

6. M.M.Schwartz, **Composite Materials Hand book** –, McGraw Hill.

7.RakeshRath, **Nanotechnology**, S.Chand and company.

Course Outcomes:

Students will be able decide the application of various newer materials to engineering applications satisfying requirement of machinability, strength and weight requirements.

Professional Elective -I

TOOLING FOR MANUFACTURING IN AUTOMATION

			Credits	:	4
Sub Code	:	18 MTE242	CIE Marks	:	40
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	SEE Marks	:	60

Course Objective:
Students are introduced to metal cutting principles, cutting tool materials, types of cutting tools and its nomenclature. Students get orientation into clamping methods and jigs used in automated environment.

Course Content:

Module-1

Mechanics of metal cutting: Introduction, measurement of cutting forces and chip thickness, force components, chip formation and primary plastic deformation, shear plane and slip line theories for continuous chip formation.
Modern Cutting tool materials: Material properties, HSS related materials, sintered tungsten carbide, cermets, ceramics, polycrystalline tools, tool coatings, coating methods, conventional coating materials, diamonds and CBN

Cutting tools: Basic types of cutting tools, turning tools, indexable inserts, groove geometry, edge preparation, wiper geometry, insert clamping methods, tool angles, threading tools, grooving and cut off tools, milling tools, types of milling cutters, milling inserts and edge clamping methods. Selection and application of Single point cutting tool and multipoint cutting tools.

10Hours

Module-2

Optimization: Machining cost and production rate verses cutting speed, role of computerized optimization system, economic considerations, optimization of machining system, machining conditions, constraints, depth of cut feed and speed.

Tooling Requirements for CNC Machines: Tool holding systems modular and quick change tool holding system, tool holder spindle connection, cutting tool clamping systems, milling cutter driver, side lock type chuck, collet chucks, hydraulic chucks, milling chucks. Tool magazines, Automatic Tool Changers, robotized tool assembly, tool management system. Tool monitoring, presetting and offsets, wear and radius compensation **10 Hours**

Module-3

Location and Clamping Methods: Basic principles of locating, locating methods & devices, Basic principles of clamping, clamping methods.

Fixtures: Definitions, General considerations, Machine considerations, Process considerations, Product considerations, Types of fixtures, Milling fixtures, Boring fixtures, Broaching fixtures, Lathe fixtures, Grinding fixtures, Steps involved in designing a fixture. 10 **Hours**

Module-4

Fixtures for Automation: Work holders for CNC, Fixturing in FMS: Part holding on Pallets, standard fixtures, pallet changers, pallet pool, flexible fixturing – principles and methodologies, modular fixturing system: T-slot based, dowel pin based, fixturing components, computer aided fixture design – locating and clamping, use of GD & T in fixture design, fixture database.

10 Hours

Module-5

Plastics for tooling materials: Introduction, Commonly used plastics for tooling, Epoxy plastics tools, Construction methods, Urethane dies, Force calculation for Urethane pressure pads.

10 Hours

Textbooks:

1. Cyrol Donaldson, **Tool Design -**, Tata McGraw Hill, India.
2. Edward G Hoffman, **Fundamentals of Tool Design** -, SME, USA.
3. Joshi, **P.H., Jigs & Fixtures**, Second Edition, Tata McGraw-Hill Publishing Company Limited,New, Delhi 2004
4. Hiram E Grant, **Jigs and Fixture** Tata McGraw-Hill, New Delhi, 2003

Reference Books:

1. William E Boyes, **Handbook of Jigs & Fixtures Design -**, SME, USA.
2. G.R. Nagpal, **Tool Engineering & Design** -, Khanna publications.
3. David A.Stephenson, John S. Agapiou, **Metal cutting theory and practice,** , Second edition CRC taylor and Francis publishers.
4. Dr. B.J. Ranganath, **Metal cutting and tool design**, Vikas publishing house
5. ASTME**; Die Design Hand book**; McGraw Hill.
6. **Metal cutting applications Engineering course material** – by Kennametal.

Course Outcome:

Students are able to decide a type of tool appropriate for machining a material, decide on nomenclature parameters and be able to design a clamping method.

Professional Elective -I

TESTING OF MATERIALS

Credits : 4

Sub Code	**: 18MTE243**	**CIE Marks**	**: 40**
Hrs/ Week	**: 04**	**Exam Hours**	**: 03**
Total Hrs.	**: 50**	**SEE Marks**	**: 60**

Course Objective:

Students are oriented to various testing methods used to characterize materials in engineering applications.

Course Content:

Module-1

Testing machines and sensors: types of Universal Testing machines and principles of operations, Machine stiffness, load and strain measurement. Calibration and verification of UTM.

Friction, wear and surface testing: Testing of sliding contact, damage, abrasive wear, adhesive wear, erosive wear. Testing and determination of surface characteristics of solid materials. (Surface roughness measurements)

10 Hours

Module-2

Importance of calibration of Testing Instruments: Calibration methods and standards .Tests / experiments based on methods with active reference to various codes and standard for each test.

Failure Analysis: Principles and Approaches of Failure analysis, objectives, scope, planning, preparation. Failure Analysis procedures.examination of damages and materials evaluation. Tools and Techniques in FA – An overview. Appearances of fracture in common conditions like unit axial loads, tensional and shear loads, fatigue and creep loading.

10 Hours

Module-3

Microscopy : Optical microscope, scanning electron microscope. Preparation of Specimens for microscopic study**.**

Speed & Control of Testing : Background ,Developments in testing Machine Technology, Effects of testing rates on properties ,Results before servo control ,Results from servo controlled machines.

10Hours

Module-4

Strain Rate Testing Aim of Recommendations ,Abbreviations and Symbols ,Test Machine Requirements
Specimens Measurements , Data Processing , General Definitions Strength Hardening Constitutive Relations to Model Material Strain Rate Dependency.

10 Hours

Module-5

Lubrication & Determination of characteristics of lubricants: Introduction, Types of lubricants, characteristics of lubricants Methods of lubrication,four ball testing. **10 Hours**

TEXT BOOKS:

1. Testing of Metallic Materials – A.V.K. Suryanarayan , Prentice Hall of India.
2. Inspection of Materials, Vol. II – Destructive Meth ods, R.C. Andersen, ASM 1988.

REFERENCE BOOKS:

1. ASM Vol Testing of materials
2. Workability Testing Techniques, G.E. Dieter, ASM 1984.
3. Relevant codes and standards.

Course outcome:

Students will be able to understand and correlate various testing methods used in industries.

Professional Elective-II

PRODUCT DESIGN TECHNOLOGY

			Credits	:	4
Sub Code	:	18MTE251	CIE Marks	:	40
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	SEE Marks	:	60

Course Objective:

The course aims at making students learn product design process, product planning and specification.

Course Content:

Module-1

Introduction: Characteristics of successful product development who Designs and develops products, duration and cost of product development, the challenges of product development.

Development Processes and Organisations: A generic development process, concept development; the front-end process, adapting the generic product development process, the AMF development process, product development organizations, the AMF organization.

10 Hours

Module-2

Product Planning: The product planning process, identify opportunities, Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process.

Identifying Customer Needs: Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of needs and reflect on the results and the process.

Product Specifications: What are specifications, when are specifications established, establishing target specifications setting the final specifications.

Concept Selection: Overview of methodology, concept screening, concept scoring, caveats.

10 Hours

Module -3

Concept Testing: Define the purpose of concept test, choose a survey population , choose a survey format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process.

Product Architecture: What is product architecture, implications of the architecture, establishing the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues.

10 Hours

Module-4

Industrial Design: Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, managing the industrial design process, assessing the quality of industrial design.

Design for Manufacturing: Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact the DFM on other factors.

10 Hours

Module-5

Ergonomics and Aesthetics in Design, Prototyping: Prototyping basics principles of prototyping, technologies, planning for prototypes.

Product Development Economics: Elements of economics analysis, base case financial mode. Sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis.

Managing Projects: Understanding and representing task, baseline project planning, accelerating projects,, project execution, postmortem project evaluation.

10 Hours

Text Book:

1. **Product Design and Development**: Karl. T. Ulrich, Steven D. Eppinger,.Irwin McGraw Hill.
2. **Product Design for Manufacture and Assembly,** GeofferyBoothroyd, Peter Dewhurst and Winston Knight..

Reference Books:

1. **Product Design and Manufacturing,** A C Chitale and R C Gupta, PH1.
2. **New Product Development,**Timjones. Butterworth Heinmann, Oxford, UCI.1997.

Course Outcome:

Students will be able to demonstrate their knowledge in various aspects of product development.

Professional Elective-II

RAPID PROTOTYPING

			Credits	:	4
Sub Code	:	18MTE252	CIE Marks	:	40
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	SEE Marks	:	60

Course Objective

The course enables students to conceive, design, and implement products quickly and effectively, using the latest rapid prototyping methods and CAD/CAM technology .The students learn to differentiate various process parameters associated with Rapid manufacturing technique .

Course Content:

Module-1

Introduction: Definition of Prototype, Types of prototype, Need for the compression in product development, History of RP systems, Survey of applications, Growth of RP industry, classification of RP systems.

Stereo lithography Systems: Principle, Process parameter, process details, Data preparation, data files and machine details, Application. **10 Hours**

Module-2

Selective Laser Sintering: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, Fusion Deposition Modelling**:** Principle, Process parameter, Path generation, Applications.

10 Hours

Module-3

Solid Ground Curing: Principle of operation, Machine details, Applications, **Laminated Object Manufacturing**: Principle, of operation, LOM materials, process details, application.

Concepts Modelers: Principle, Thermal jet printer, Sander's model market, 3-D printer, GenisysXs printer HP system 5, object Quadra systems, **Laser Engineering Net Shaping (LENS)**

10 Hours

Module-4

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Rapid Tooling : Indirect Rapid tooling -Silicon rubber tooling —Al uminum filled epoxy tooling Spray metal tooling ,Cast kirksite ,3D keltool ,etc ,Direct Rapid Tooling — Direct, AI M, Quick cast process, Copper polyamide, Rapid Tool ,DMILS, ProMetal ,Sand casting tooling ,Laminate tooling soft Tooling vs. hard tooling.

10 **Hours**

Module-5

Software ForRp: Stl files, Overview of Solid view, magics, imics, magic communicator, etc. Internet based software, Collaboration tools,

RAPID Manufacturing Process Optimization: factors influencing accuracy, data preparation errors, Part building errors, Error in finishing, influence of build orientation.

Allied Processes: vacuum, casting, surface digitizing, surface generation from point cloud, surface modification — dat a transfer to solid models.

10 Hours

Text Books:

1. Paul F. Jacobs: " **Stereo 1ithography and other RP & M Technologies**"-SME NY, 1996.
2. Flham D.T &Dinjoy S.S " **Rapid Manufacturing**"- Verlog London 2001.

Reference Books:

1. Terry Wohler's " **Wohler's Report 2000** "- Wohler's Association 2000

Course Outcomes:

1. Students can express the concept of product design stages and methods, thereby making him a better product designer.
2. Student can assess and implement RP techniques for specific application leading to better ROI for the company that uses RP machines

Professional Elective-II

NON-TRADITIONAL MACHINING

		Credits	**: 4**
Sub Code	**: 18MTE253**	**CIE Marks**	**: 40**
Hrs/ Week	**: 04**	**Exam Hours**	**: 03**
Total Hrs.	**: 50**	**SEE Marks**	**: 60**

Course learning objectives:

1. To demonstrate the need for development of newer/ non-traditional machining processes.

2. The student will be able to identify different energy sources like fluid motion, electric current, high speed electrons, high energy radiation, etc.

3. To analyse the concept, mechanism, parameters associated with the processes.

4. To demonstrate the operational principles, advantages applications, limitations of the various non-traditional machining processes.

Course Content:

Module-1

Introduction: Need for non-traditional machining processes, Process selection, classification, comparative study of different processes.
Abrasive Jet Machining: Principle, Process parameters, Influence of process parameters on MRR , applications, advantages and disadvantages.
Water Jet Machining: Principle, Equipment, Operation, Application, Advantages and limitations of water Jet machinery.

10 Hours

Module-2

Thermal Metal Removal Processes: Electric discharge machining, Principle of operation, mechanism of metal removal, basic EDM circuitry, spark erosion generators, Analysis of relaxation type of circuit, material, removal rate in relaxation circuits, critical resistance parameters in Ro Circuit, Die electric fluids, Electrodes for spark erosion- surface finish, applications.
Electro Chemical machining (ECM): Classification of ECM process, Principle of ECM, Chemistry of the ECM process, parameters of the process, Determination of the metal removal rate, dynamics of ECM process, Hydrodynamics of ECM process, polarization, Tool Design, advantages and disadvantages-applications. Electro Chemical grinding, Electro Chemical honning, Electrochemical deburring. **10 Hours**

Module-3

Chemical Machining: Introduction, fundamental principle types of chemical machining, Maskants, Etchants, Advantages and disadvantages, applications, chemical blanking, chemical milling (contour machining), Hydrogen embrittlement.

Plasma arc Machining: Introduction, Plasma, Generation of Plasma and equipment, Mechanism of metals removal, PAM parameters, process characteristics, types of torches, applications.
Electron beam machining(EBM): Introduction, Equipment for production of Electron beam, Theory of electron beam machining, Thermal & Non thermal type, Process characteristics, applications. **10 Hours**

Module-4

Laser Beam Machining: Introduction, principles of generation of lasers, Equipment and Machining Procedure, Types of Lasers, Process characteristics, advantages and limitations, applications of laser beam machining. CO_2 Laser: Principle, Equipment, Applications.
Ion Beam Machining: principle, equipment, working, sputtering rate, applications.

10 Hours

Module-5

High Velocity forming processes: Introduction, development of specific process, selection, comparison of conventional and high velocity forming methods. Types of high velocity forming methods: explosion forming process, electro-hydraulics forming, magnetic pulse forming. Applications,Advantages and limitations.
Ultra Sonic Machining: Definition, Mechanism of metal removal, elements of the process, Tool feed mechanisms, Theories of mechanics, effect of parameters, Different types of concentrators, horn design, applications, Limitations**.**

10 Hours

Text Books:

1. **Modern Machining Process -** P.C Pandy& H.S Shan Tata McGraw Hill.
2. **Modern Machining Processes -** P.K Mishra
3. **Thermal Metal Cutting Processes**- Dr.B.J.Ranganath, I K International,New Delhi.

Reference Books:

1. **New technology -** Bhattacharya, Institution of Engineers, India
2. **Production technology -** HMT Tata McGraw Hill.
3. **Metals hand book** - ASM Vol-3.
4. **High velocity forming of metals -** F.M Wilson ASTME PreticeHall.
5. **Modern Manufacturing Methods -** Adithan

Course Outcomes:

1. Student will be in a position to appreciate the merits of non traditional machining and its application in Industries.
2. Justify and demonstrate the benefits of non-traditional machining processes over traditional machining processes.
3. Students will be able to decide a process suitable for a particular material based on the availability of the sources.

Manufacturing Engineering Lab- 2

Credits :2

Subject Code:18MTEL26	Hours/Week : 4
CIE Marks : 40	Exam Hours: 3
Total Hours : 48	SEE Marks : 60

Note:

1) These are independent laboratory exercises
2) A student may be given one or two problems stated herein
3) Student must submit a comprehensive report on the problem solved and give a Presentation on the same for Internal Evaluation
4) Any one of the exercises done from the following list has to be asked in the Examination for evaluation.

Exercises:

1. Study waviness produced by grinding process and characterize the resulting surface.
2. Develop and implement a program for pick and place of an object by a robot..
3. Modeling and simulation using MATLAB of a vibration control system and to draw time response/ frequency response curves.
4. Kinematic analysis of forward/reverse linkages of robots using MATLAB(Denavit-Hartenberg convention).
5. Trajectory planning of robots using MATLAB.
6. Design and analysis of PID controller for mechanical engineering applications using MATLAB.
7. Reduce MLT using Lean principles that are followed in major industries (using case studies and data from industries and make a proposal for redesigning existing machine shop).
8. To develop a CIM Layout consisting of 3 machining centers, one AGV and 3 material handling robots. Layout developed must indicate complete CIM environment consisting of tool crib, raw material storage and finished product storage area. (using solid edge, Autocad or any other available software).
9. Monitoring of vibrations/noise of a machine tool and to compare it with industry standards. List the causes of variation and suggest remedial measures.
10. Detection, location and characterization of defects in castings / welds/ adhesive bonds.

SYLLABUS
SEMESTER-III

PLASTIC MOULDS DESIGN

Credits :4

Sub Code	:	18MTE31	CIE Marks	:	40
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	SEE Marks	:	60

Course Objective:

The course aims at giving an insight into various aspects of plastic moulds design.

Course Content:

Module-1

Introduction to Plastics: Monomer, Polymer, Degree of Polymerisation, Classification of Plastics, General review of Properties, Application and Processing, Behaviors of various plastics PE, PP, PYC, PMMA, ABS, NYLON, Polyacetal, Polycarbonate, PTFE, PF, UF & MF.

Mould Construction: Parting Surfaces:Straight, stepped, curved parting surface.Design of various Injection mould elements, cores, cavities, and inserts, fitting core and cavity inserts, pillars and bushes.

10 Hours

Module-2

Feed and Ejector System: Design of optimum Gates, Runners, Impressions, Layout, Sprue, sprue pullers, mould shrinkage. Types of ejection, Ejector grids, ejection methods, Ejector Pin, Sleeve ejection, plate ejection, Blade ejection, Air ejection, Ejection from fixed half, Double ejection, Delayed ejection.

10Hours

Module-3

Cooling System: Need for cooling, cooling solid cores and cavities, insert cooling, cooling long cores, cooling elements, baffles, bubblers etc., and cooling calculation.

Parting Surfaces: Straight, stepped, curved parting surface. **10Hours**

Module-4

Moulds with External Under Cuts: Split moulds, Actuation of splits, Guiding of splits, side cores.
Special Moulds: Form pins Moulds for threaded components: External threads, internal threads, Moulds with loose cores, Automatic unscrewing type of moulds,Under feed moulds, 3 Plate moulds, hot runner moulds (Runner less moulds), Multi color moulding tools, Defects in moulding and its remedies, Compression moulding tools, transfer moulding tools .

Moulds with internal under cuts : Form pins
Moulds for threaded components: External threads, internal threads, Moulds with loose cores, Automatic unscrewing type of moulds.
Under feed moulds :3 Plate moulds, hot runner moulds (Runner less moulds)
Multi colormouldingtools: Defects in moulding and its remedies, Compression moulding tools, transfer moulding tools.

10 Hours

Module-5

Design of: the following types of moulds:

1. Two plate moulds with pin ejection and edge gate.
2. Two plate moulds with sleeve ejection and submarine gate
3. Two plate moulds with stripper plate ejection
4. Two plate moulds with internal undercut
5. Two plate moulds with spilt mould and mould with side core
6. Two plate moulds for threaded parts (loose core and automatic rack & pinion design).
7. Three plate moulds with multi impressions
8. Compression moulds
9. Transfer moulds

NOTE:draw proportionate sketches of the designed moulds on graph sheets or plain sheets

10 Hours

Text Books:

1.Injection Mould Design, Pye. R. G. W., New York – JohnWiley&Sons.

2.Hand book of Plastic Processes, Charles A. Harper.

3.Injection Mould Design, Pye R.G.W., New-York -John Wiley &. Sons 12th Ed. 1989.

Reference Books:

1.Injection Moulding Theory & Practice, Rubin. J. Irvin, New York-John Wiley & Sons 1976.

2.Injection Mould 108 Proven Design, Gastro, London -Applied Science Pub. 9th Ed. 1982.

3. 101 proven design by RGW Pye

Course Outcome:

Students will be able to understand various concepts of molds and do the mold design.

Professional Elective –III

ADVANCED MOULDING TECHNIQUES

Credits	**:4**				
Sub Code	**:**	**18MTE321**	**CIE Marks**	**:**	**40**
Hrs/ Week	**:**	**04**	**Exam Hours**	**:**	**03**
Total Hrs.	**:**	**50**	**SEE Marks**	**:**	**60**

Course Objective:
The course gives complete overview of advanced moulding techniques in various industrial applications.

Course Content:

Module-1

Injection Moulding Technology : Microprocessor control injection moulding machine, close loop control, open loop control, CNC control, multi color injection moulding, rotary injection moulding, structural foam moulding, sandwich injection moulding**.**

Metal injection moulding: contact injection moulding, moulding of cellular product like EPS, steam chest moulding, future trends in injection moulding like external & internal inter locking alignment of large moulds, processing of specialty polymers.

10Hours

Module-2

Extrusion : General consideration during extrusion process like specific heat, latent heat, internal conductivity, shape & size of granular hygroscopic nature over temperature, effect of flow property like relaxation time & defects like shark skin, elastic turbulence, influence of TG, TM & crystal growth rate, cooling rate, impact strength, manufacturing of woven sacks etc. co extrusion, co extruded pipe, muilt layer pipe, foam pipe, biaxial oriented pipe.

10 Hours

Module-3

Lamination : Lamination by extrusion coating, twin screw extrusion, co-rotating & counter rotating, feeding mechanism in twin screw extruder, roll of side feeder & injection feeder, principles of compounding, mixing mechanism etc**.**
PTFE Moulding : Processing techniques used for PTFE, Material consideration, sintering, Ram extrusion, and Paste extrusion, lso statistic. Moulding and skewing technique for PTFE processing.

10 Hours

Module-4

Blow Moulding : Micro processor / CNC controlled blow moulding machine, injection stretch blow moulding of PET, precut moulding, multi layer blow moulding, Parission programming.

Reaction Injection Moulding (RIM): RIM of Polyurethane, material for RIM, liquid RIM & its advantages over conventional injection moulding, RRIM.

10 Hours

Module-5

Advancement in Other Processing Technique : New techniques like Resin transfer moulding, Pultrusion. Filament winding, multi layer rotation moulding, Electro plating and printings, Centrifugal casting, Shrink film, Clink film.

10 Hours

TEXT BOOKS:

1. Injection Moulding,by Rubin.
2. Extrusion –Berln.
3. **Injection Mold by Glavin & Denton**

REFERENCE BOOKS:

1. Extrusion Die Design, M. V. Joshi.
2. Polymer Chemistry, Gowriker

Course Outcome:

Students will be able to demonstrate their knowledge in the field of advanced moulding methods.

Professional Elective--III

NANO SCIENCE AND NANOMATERIALS

Credits :4

Sub Code	**:**	**18MTE322**	**CIE**	**:**	**40**
Hrs/ Week	**:**	**04**	**Exam Hours**	**:**	**03**
Total Hrs.	**:**	**50**	**SEE Marks**	**:**	**60**

Course Objective:

The Course gives exposure to Nanoscience and Naonotechnology, its properties and design

Course Content:

Module-1

Introduction To Nanoscience And Nanotehnology : History, background scope and interdisciplinary nature of nanoscience and nanotechnology, scientific revolutions, nanosized effects surface to volume ratio, atomic structure, molecules and phases, energy at the nanoscale molecular and atomic size,quantumeffects,types of nanotechnology and nano machines.

Classification Of Nanostructures: Zero dimensional,one-dimensional and two dimensional nanostructure materials-clusters of metals, semiconductors, ceramics and nanocomposites, sizedependent phenomena, quantumdotsnanowires,tubes,nanosheets,nano and mespores, topdown and bottomupsapproachs, misnomers and misconception of nanotechonology, importance of nanoscalematerials and their devices. **10 Hours**

Module-2

Properties Of Nanomaterials: Mechanicalproperties-Thermo physical properties - Electrical properties Electric properties – Electro chemical properties Magnetic p roperties - optical properties-Catalytic property – properties of gas permeation and separation membranes.

Nanostructure Design: Functionality of nanostructures and their characteristics evaluation, size effect in semiconductor nanoparticles – particle size, shape density – Melting point, surfa ce tension, wettability – specific surface area and pore – Assembly of nanoparticles and fictionalization – nanoparticles arranged structure s as nanipores and nanocomposites – Structure contr ol of nanoparticle collectives by sintering and bounding – Self – assembly. Nanoparti cle dispersion and aggression behaviour – Single na noparticle motion in fluid – Brownian diffusion – Adsorption properties – intera ctions between particles – Aggregation and dispersi on, characterization and control – Rheology of slurry – Simlation of colloidal dispers ion system.

10Hours

Module-3

Melting Point And Phase TranitionProcesses :quantum-size-effect (QSE) Size-induced metal-insulator-transition (SIMIT) nano-scale magnets, transparent magnetic materials and ultrahigh-density magnetic recording materials – chemical physical of atomic and molecular clusters. Surface energy – chemical potential as a function of surface curvature – Electrostatic stabilization – surface charge dens ity-electric potential at the proximity of solid surface-van der Waals attraction potential. Photochemistry, Photoconductivity, Electrochemistry of nanomaterials – Diffusion in Nanomaterials ,Nanoscale Heat transfer, Catalysis by Gold Nanoparticles, Transport in semiconductor Nanostructures, Transition Metal Atoms on Nanocarbon Surfaces, Nano deposition of soft materials, Nanocatalysis.**Surface Modification Of**

10 Hours

Module-4

Application Of Quantum Dots For Bio-Medical Engineering: Bio- imaging with quantum dots – Pinpoint drug and gene delivery- delivery to the brain – Development of the thermo responsive magnetic nanoparticle and its deployment in the biotechnology field, Addressing of nanoparticles by using DNA molecules, Nanoparticle formation of DNA (globule transformation) – Development and multi-functionali zation of high – functional separation membranes – Design of nanoparticles for oral delivery of peptide drugs.

10 Hours

Module-5

Smart Materials And Systems : Thermoresponsive materials, piezoelectric materials, electrostrictive and magnetostrictive materials, ferrofluids, ER and MR fluids, biomimetic materials, smart gel, shape memory alloys and polymers, actuation methods, measurements. **Nanoparticles:** Surface modification of inorganic nanoparticles by organic functional groups Instantaneous nano foaming method for fabrication of closed –poro sity silica particle- Development of photo catalyst inserted into surface of porous alumina silicate- Fabrication technique of organic nano crystals and their optical properties and matetialization, Dispersion control of nanoparticles in solvents – Development of new cosm etics based on nanoparticles – Development of funct ional skincare cosmetics using

biodegradable PLGA nano spheres**.**

10 Hours

TEXT BOOKS:

1. **.**Edward L. Wolf. “Nanophysics and Nanotechnology” – An Introduction to Modern Concepts in Nanoscience“ Second Edition, John Wiley & Sons, 2006.
2. K.W. Kolasinski, “Surface Science Foundation of Cat alysis and Nanoscience “, – Wiley, 2002
3. G.A. Ozin and A.C. Arsenault, “Nanochemistry: A che mical approach to Nanomaterials” , 2005.
4Nanostructues and Nanomaterials Synthesis, Properties and applications, G.Cao Imperial Collage Press 2004.

REFERENCEBOOKS :

Valdimir P, Torchilin (2006) Nanoparticulates as Drug Carriers imperial college press.
1. M Reza Mozafari (2007) Nanomaterials and Nanosystems for Bio-Medical Applications springer.
2. Nanotechnology – Basicscience and emerging technolo gies Chapman and Hall/CRC(2002).
3. Nanomaterials and Nanotechnologies and design on introduction for engineers and architects, Micheal F. Ashby, P.J. Ferreria, D.L. Sehodek.

Course Outcome:

Students will be able to understand the importance of nanoscience and nanomaterials in industrial applications.

Professional Elective--III
MATERIAL FLOW ANALYSIS

Credits :4

Sub Code	:	18MTE323	CIEMarks	:	40
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	SEE Marks	:	60

Course Objective:
The course gives insight into material flow in sheet metal working

Course Content:

Module-1

Introduction: Modeling, meshing, Boundary conditions, Loads, Optimization.

10 Hours

Module-2

Sheet Metal Analysis I : Metal Flow Analysis, Heat analysis, Micro structure analysis, Stress analysis, Thermo mechanic processing, Heat transfer analysis.

Sheet Metal Analysis II: Residual stress analysis, Static analysis, Contact analysis, Buckling analysis, Bending analysis, Natural frequency.

10 Hours

Module-3

Mold Analysis: Shrinkage analysis, Warpage analysis, Flow analysis.
Die Casting Analysis I :3D -mesh generation, Heat flow, fluid flow, Stress and Strain.

Die Casting Analysis II: Microstructure modeling, inverse modeling, die life estimation.

10 Hours

Module-4

Softwares I: Mold flow, Pro-cast; Pro-Mechanica, De-form.

10 Hours

Module-5

Softwares II: Mold flow, Pro-cast; Pro-Mechanica, De-form.

10 Hours

Reference Book:

1. **Operating Manuals of Mold Flow,** PSG-cast, PSG Mechanica, Deform.

Course Outcome:
Students will be able to make analysis of material flow, shrinkage, wrappage and microstructure analysis.

Professional Elective-IV
DESIGN FOR MANUFACTURE

Credits :4

Sub Code	**: 18MTE331**	**CIE Marks**	**: 40**
Hrs/ Week	**: 04**	**Exam Hours**	**: 03**
Total Hrs.	**: 50**	**SEE Marks**	**: 60**

Course Objective:

Student will have clear understanding of factors and considerations to be considered in designing parts and components in engineering applications.

Course Content:

Module-1

Effect of Materials And Manufacturing Process On Design: Major phases of design. Effect of material properties on design Effect of manufacturing processes on design. Material selection process- cost per unit property, Weighted properties and limits on properties methods.

Tolerence Analysis: Process capability, mean, varience, skewness ,kurtosis, Process capability metrics, Cp, Cpk, Cost aspects, Feature tolerances, Geometries tolerances, Geometric tolerances, Surface finish, Review of relationship between attainable tolerance grades and different machining process. Cumulative effect of tolerance- Sure fit law and truncated normal law.

10 Hours

Module-2

Selective Assembly: Interchangeable part manufacture and selective assembly, Deciding the number of groups -Model-1 : Group tolerance of mating parts equal, Model total and group tolerances of shaft equal. Control of axial play-Introducing secondary machining operations, Laminated shims, examples.

Datum Features : Functional datum, Datum for manufacturing, Changing the datum. Examples.

10 Hours

Module-3

Design Considerations : Design of components with casting consideration. Pattern, Mould, and Parting line. Cored holes and Machined holes. Identifying the possible and probable parting line. Casting requiring special sand cores. Designing to obviate sand cores.

Component Design : Component design with machining considerations link design for turning components-milling, Drilling and other related processes including finish- machining operations.

10 Hours

Module-4

True positional theory : Comparison between co-ordinate and convention method of feature location. Tolerance and true position tolerancing virtual size concept, Floating and fixed fasteners. Projected tolerance zone. Assembly with gasket, zero position tolerance. Functional gauges, Paper layout gauging.

10 Hours

Module-5

Design of Gauges: Design of gauges for checking components in assemble with emphasis on various types of limit gauges for both hole and shaft. **10 Hours**

Text Books:

1. Designing for Manufacturing - Harry Peck, Pitman Publications, 1983.
2. Machine Design - Dieter McGraw hill Publications for topic 1.
3. Metrology - R.K. Jain Khanna Publication for topic 6.
4. Product design for manufacture and assembly - Geoffrey Boothroyd, peter dewhurst, Winston Knight, Merceldekker. Inc. New york.
5. Material selection and Design, Vol. 20 - ASM Hand book.

Course Outcome:

Students will be able to demonstrate their understanding of tolerance specification and considerations to be given importance in design for manufacture.

Professional Elective--IV

NON DESTRUCTIVE TESTING

Credits :4

Sub Code	:	18MTE332	CIE Marks	:	40
Hrs/ Week	:	04	Exam Hours	:	03
Total Hrs.	:	50	SEE Marks	:	60

Course Objective:

Exposure to various non destructive testing methods in essential in advanced manufacturing applications, the course aims at giving an insight into various Non Destructive Testing methods used in practice.

Course Content:

Module-1

Introduction to ND Testing: selection of ND methods, visual inspection,leak testing, Liquid penetration inspection, its advantages and limitation.

Magnetic Particle Inspection: Methods of generating magnetic field, typesof magnetic particles and suspension liquids steps in inspection – application and limitations **.** **10 Hours**

Module-2

Eddy Current Inspection: principles, operation variables, procedure,inspection coils, and detectable discounts by the method.

Ultrasonic Inspection: Basic equipment characteristics of ultrasonic waves,variables inspection, inspection methods pulse echo A,B,C scans transmission, resonance techniques, transducer elements couplets, search units, contact types and immersion types inspection standards-standard reference blocks. **10Hours**

Module-3

Radiography Inspection: principles, radiation source X-rays and gammarays, X-ray-tube, radio graphic films, neutron radiography, Thermal inspection principles, equipment inspection methods applications.
Microwave Inspection: Microwave holography, applications andlimitations.

10Hours

Module-4

Optical Holography: Basics of Holography, recording and reconstruction -Acoustical Holography: systems and techniques applications.Indian standards for NDT. **10 Hours**

Visual Inspection and Thermographic methods : Acoustic emission, Total acoustic emission, felicity ratio, Generation of Acoustic Emission**.** **10 Hours.**

TEXT BOOKS:

1. The Testing Instruction of Engineering Materials - Davis H.ETroxel G.E wiskovil C.T - McGraw hill.

REFERENCE BOOKS:

1. Non Destructive Testing - McGonnagle JJ – Garden an d reachNew York.
2. Non Destructive Evolution and Quality Control - volume 17 ofmetals hand book 9 edition Asia internal 1989.

Course Outcome:

Students will be able to understand significance and suitability of various non destructive testing methods in industrial applications.

Professional Elective--IV

COMPUTER CONTROL OF MANUFACTURING SYSTEMS

Credits :4

Sub Code	: 18MTE 333	CIE Marks	: 40
Hrs/ Week	: 04	Exam Hours	: 03
Total Hrs.	: 50	SEE Marks	: 60

Course Objectives:

1. To impart the basic concepts in manufacturing systems and fundamentals of NC & CNC system
2. Knowledge enhancement in design consideration and increasing productivity with NC machine tools, machining centers and tooling for CNC machines
3. To enhance students awareness in system devices that include feedback devices, counters, DAC converters and interpolators

Course Content:

Module-1

Introduction to Computer integrated Manufacturing Systems: Manufacturing Systems, Types of Manufacturing Systems, , Machine Tools and related equipment's, Material Handling Systems, Computer monitoring and control, Manufacturing support systems, The Product Cycle and CAD/ CAM, Functions of computers in CIMS: CIMS Data Files, System Reports, Benefits of Computer integrated Manufacturing Systems,

NC/ CNC Machine Tools: General architecture of CNC Machine, Components of the CNC Systems: Machine Control Unit , CNC Driving system components: Hydraulic, Servo Motors, Stepper Motors, Feedback Devices: Encoder, Resolver, Inductosyn, Tachometers, Counting devices, Digital to analog converters. **10 Hours**

Module-2

Interpolations: DDA integrators, simple and symmetrical DD reference word CNC interpolators. **Control loops for N C Systems:** Introduction-control loops for point and counting systems.

Constructional Features of CNC Machines: Design considerations of CNC machines for improving machining accuracy, Structural Members, Slide ways, bearings, Re-circulating ball Screws, Spindle drives, Work holding devices and tool holding devices, Automatic tool changers: Principles of Operation, Machining Centres, Tooling for CNC machines.

10 Hours

Module-3

N.C part programming: Introduction, NC/ CNC programming methods: Manual part programming for turning and milling centers, G codes, M codes, canned cycles, Programming with CAD/CAM integration, CAM packages for CNC part program generation, Practical Exercises on CNC part programming.

Computer Controls in NC: CNC Technology: Functions of CNC Control in Machine Tools, Advantages of CNC, Direct Numerical Control(DNC Systems): Configuration of DNC system, , Functions of DNC, Communication between DNC computer & MCU, Advantages of DNC, Adaptive control machining systems. Adaptive control optimization system, adaptive control constraint system, applications to machining processes, Benefits of Adaptive control machining.

10Hours

Module-4

Industrial Robotics : Robotics technology : Types of Robots, Robot Technology Levels, Robot geometric configurations and Technical Features, basic robot motions, Robot control systems, robot drive systems, Work-cell control and Interlocks, robot sensors, robot safety, robot-computer interface, industrial robot applications and benefits, robot programming and programming languages.

10 Hours

Module-5

Computerized Manufacturing Planning and Control Systems: Computer aided process planning, Variant and Generative approaches, Computer integrated production planning and control systems, Typical production planning and control system, Material planning systems, Capacity planning, Shop Floor Control, Automatic identification, Automated data collection systems.

10 Hours

TEXT BOOKS:

1. GROOVER M P, **Automation, Production Systems and Computer Integrated Manufacturing -**, Prentice Hall India (P) Ltd, 1989.
2. Mikell P. Groover and Emory W. Zimmer, Jr., **CAD/CAM Computer Aided Design and Manufacturing,** Prentice Hall India (P) Ltd, 1992. (unit 1)
3. M.Koren **—Computer Controls of Manufacturing Systems,** McGrawHill, 1983

REFERENCE BOOKS:

1. Martin J. **—Numerical control of machine tools".**
2. P.N. Rao – CAD/CAM **Principles and Applications**McGrawhill 2002
3. Y. Koren&J.Benuri -**"Numerical control of machine tools** -Khanna, 1992
4. Wilson F.M **—Numerical control in manufacturing**- McGraw Hill Newyork
5. Suk-Hwan Suh, Seong-Kyoon Kang, Dea-Hyuk Chung and Ian Stroud, **Theory and Design of CNC Systems**, , Springer, 2008

Course Outcome:

Students will get clear understanding of:

1. NC/CNC machines, Various elements of CNC machines and its uses.
2. Constructional features of CNC machine Tools
3. Knowledge of CNC programming and its implementation.