Rashtreeya Sikshana Samithi Trust

R.V. College of Engineering

(Autonomous Institution affiliated to VTU, Belagavi)

Department of Mechanical Engineering

Master of Technology (M.Tech.)

Product Design and Manufacturing

Scheme and Syllabus of Autonomous System w.e.f 2016

VISION

Quality education in Design, Materials, Thermal and Manufacturing with emphasis on research, sustainable technologies and entrepreneurship for societal symbiosis.

MISSION

- Imparting knowledge in basic and applied areas of Mechanical Engineering.
- Providing state-of-the-art laboratories and infrastructure for academics and research in the areas of design, materials, thermal engineering and manufacturing.
- Facilitating faculty development through continuous improvement programs.
- Promoting research, education and training in materials, design, manufacturing, Thermal Engineering and other multidisciplinary areas.
- Strengthening collaboration with industries, research organizations and institutes for internship, joint research and consultancy.
- Imbibing social and ethical values in students, staff and faculty through personality development programs

Program Educational Objectives (PEO)

M.Tech in Product Design and Manufacturing Graduate will be able to

PEO1: Demonstrate knowledge and understanding of engineering principles to design and analyze products and their manufacturing processes.

PEO2: Apply modern tools to evaluate product cost, quality and management of its life cycle.

PEO3: Create new products by synthesizing functional requirements with a concern for environment and sustainability.

PEO4: Exhibit good communication skills, ability for life long learning, team work, and professional ethics.

Program Outcomes (PO)

M. Tech. in Product Design and Manufacturing graduates will be able to:

PO1: **Engineering Knowledge**: Apply knowledge of mechanical engineering in the areas of design, manufacturing and materials to design products.

PO2: **Problem Analysis**: Identify need for new product development and design appropriate products.

PO3: **Design & Development of Solutions**: Design and implement new products with improved performance.

PO4: **Modern Tool Usage**: Use advanced software tools to design, analyze and evaluate products for its functional requirements and life cycle.

PO5: **Engineer and Society**: Develop new products considering public health and safety

PO6: **Environment and Sustainability**: Design and evaluate products considering environment and sustainability.

PO7: **Ethics**: Apply professional, legal, ethical issues while designing products

PO8: **Individual and team work**: Function effectively in teams and in diverse multidisciplinary environments to accomplish common goals.

PO9: **Communication**: Communicate effectively with diverse groups to exhibit leadership qualities in working environment

PO10: **Project Management and Finance**: Apply principles of project management for effective execution of product development and product life cycle management.

PO11: **Life-long Learning**: Pursue life-long learning for enhancing knowledge and skills.

Program Specific Criteria (PSC) as per American Society of Mechanical Engineers

The curriculum is designed to enable the students to (a) apply principles of engineering design, analysis, selection of materials and manufacturing processes using modern tools and techniques to new products; (b) be proficient in product costing, quality assessment and its life cycle management; (c) work in teams, communicate effectively, demonstrate concern for environment and sustainability of products and processes.

The faculty members of the program possess in-depth understanding and expertise in their areas of specialization with a commitment to periodically update their knowledge in respective domains.

Program Specific Outcomes (PSO)

M.Tech in Product Design and Manufacturing Graduate will be able to

PSO1: Design products, select materials and process, perform simulation and analysis for automobile, consumer goods, machine tools and allied industries.

PSO2: Apply the knowledge of quality, ergonomics, product life cycle management and costing to engineering products and systems

R. V. College of Engineering, Bengaluru – 59.

(An Autonomous Institution affiliated to VTU, Belagavi)

Department of Mechanical Engineering

M. Tech in Product Design and Manufacturing

M.TECH FIRST SEMSESTER								
Sl. No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Credits**
				L	**T**	**P**	**S**	
1	16 MEM11P	Project Management	IM	4	0	0	0	4
2	16MAT12B	Probability & Statistics for Engineers	MA	4	0	0	0	**4**
3	16MPD13	Industrial Design and Ergonomics (Theory & Practice **)**	ME	4	0	1	0	**5**
4	16MPD14	Materials and Processes for Design	ME	4	0	0	1	**5**
5	16MPD15X	Elective 1	ME	4	0	0	0	**4**
6	16MPD16	Professional Skill Development	HSS	0	0	2	0	**2**
	Total			20	0	3	1	**24**

LIST OF ELECTIVE COURSES (4 CREDITS)

Elective 1			
16MPD151	Design for Manufacture	16MPD152	Simulation of Manufacturing Systems

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Department of Mechanical Engineering

M. Tech in Product Design and Manufacturing

M.TECH SECOND SEMSESTER								
Sl. No.	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Credits**
				L	**T**	**P**	**S**	
1	16MEM21R	Research Methodology	IM	3	1	0	0	**4**
2	16MPD22	Computer Aided Engineering (Theory & Practice **)**	ME	4	0	1	0	**5**
3	16MPD23X	Elective 2	ME	4	0	0	0	**4**
4	16MPD24X	Elective 3	ME	4	0	0	0	**4**
5	16MPD25X	Elective 4	ME	4	0	0	0	**4**
6	16MPD26	Minor Projects (in-house)	ME	0	0	5	0	**5**
	Total			19	1	6	0	**26**

LIST OF ELECTIVE COURSES (4 CREDITS)

Elective -2			
16MPD231	Design of Moulds and Dies	16MPD232/16MCM232	Design of Machine tools
Elective - 3			
16MPD241	Product Cost Analysis and Optimization	16MPD242	Design for Quality
Elective - 4			
16MPD251/16MTE251	Additive Manufacturing	16MPD252	Optimization Techniques

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Department of Mechanical Engineering

M. Tech in Product Design and Manufacturing

M.TECH THIRD SEMSESTER								
Sl. No.	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Credits**
				L	T	P	S	
1	16MPD31	Creative Engineering Design & Analysis (Theory & Practice)	ME	4	0	1	0	**5**
2	16MPD32X	Elective 5	ME	4	0	0	0	**4**
3	16MPD33X	Elective 6	ME	4	0	0	0	**4**
4	16MPD34X	Elective 7	ME	4	0	0	0	**4**
5	16MPD35	Internship/Industrial Training	ME	0	0	3	0	**3**
6	16MPD36	Technical Seminar	ME	0	0	2	0	**2**
		Total		16	0	6	0	**22**

LIST OF ELECTIVE COURSES (4 CREDITS)

Elective -5			
16MPD321	Product Life cycle management	16MPD322	Lean Manufacturing Systems
Elective - 6			
16MPD331	Robust Design	16MPD332	Design of Hydraulic and Pneumatic Systems
Elective-7			
16MPD341	System Engineering	16MPD342	Industrial Robotics and Automation

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M. Tech in Product Design and Manufacturing

M.TECH FOURTH SEMSESTER								
Sl. No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Credits**
				L	**T**	**P**	**S**	
1	16MPD41	Major Project	ME	0	0	26	0	26
2	16MPD42	Seminar	ME	0	0	2	0	2
		Total		**0**	**0**	**28**	**0**	**28**

PROJECT MANAGEMENT						
Course Code	**:**	**16MEM 11P**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L: T: P: S**	**3:2:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hours**

Course Learning Objectives:

Students are able to

1. Understand the principles and components of project management.
2. Appreciate the integrated approach to managing projects.
3. Elaborate the processes of managing project cost and project procurements.
4. Apply the project management tools and techniques.

Unit – I **7 Hours**

Introduction: Project, Project management, relationships among portfolio management, program management, project management, and organizational project management, relationship between project management, operations management and organizational strategy, business value, role of the project manager, project management body of knowledge.

Unit – II **8 Hours**

Generation and Screening of Project Ideas: Generation of ideas, monitoring the environment, corporate appraisal, scouting for project ideas, preliminary screening, project rating index, sources of positive net present value. Project costing,

Project Scope Management: Project scope management, collect requirements define scope, create WBS, validate scope, control scope.

Organizational influences & Project life cycle: Organizational influences on project management, project state holders & governance, project team, project life cycle.

Unit – III **7 Hours**

Project Integration Management: Develop project charter, develop project management plan, direct & manage project work, monitor & control project work, perform integrated change control, close project or phase.

Project Quality management: Plan quality management, perform quality assurance, control quality.

Unit – IV **7 Hours**

Project Risk Management: Plan risk management, identify risks, perform qualitative risk analysis, perform quantitative risk analysis, plan risk resources, control risk.

Project Scheduling: Project implementation scheduling, Effective time management, Different scheduling techniques, Resources allocation method, PLM concepts. Project life cycle costing.

Unit-V **7 Hours**

Tools & Techniques of Project Management: Bar (GANTT) chart, bar chart for combined activities, logic diagrams and networks, Project evaluation and review Techniques (PERT) Planning, Computerized project management.

Syllabus includes tutorials for two hour per week:

- Case discussions on project management
- Numerical problems on PERT & CPM
- Computerized project management exercises using M S Project Software

Course Outcomes:

After going through this course the student will be able to

CO1: Explain the process of project management and its application in delivering successful projects.

CO2: Illustrate project management process groups for various project / functional applications.

CO3: Appraise various knowledge areas in the project management framework.

CO4: Develop project plans and apply techniques to monitor, review and evaluate progress for different types of projects.

Reference Books:

1. Project Management Institute, "A Guide to the Project Management Body of Knowledge (PMBOK Guide)", 5th Edition, 2013, ISBN: 978-1-935589-67-9
2. Harold Kerzner, "Project Management A System approach to Planning Scheduling & Controlling", John Wiley & Sons Inc., 11th Edition, 2013, ISBN 978-1-118-02227-6.
3. Prasanna Chandra, "Project Planning Analysis Selection Financing Implementation & Review", Tata McGraw Hill Publication, 7th Edition, 2010, ISBN 0-07-007793-2.
4. Rory Burke, "Project Management – Planning and Controlling Techniques", John Wiley & Sons, 4th Edition, 2004, ISBN: 9812-53-121-1

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	H	M	M	----	M	H	H	H	----	H	----
CO2	----	M	----	-----	M	H	H	H	L	H	----
CO3	---	M	H	---	M	H	H	H	H	H	M
CO4	M	H	M	L	H	H	H	H	----	H	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1		M
CO2		L
CO3	L	M
CO4	M	L

PROBABILITY AND STATISTICS FOR ENGINEERS						
Course Code	**:**	**16MAT12B**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

The students shall be able to:

1. Understand the fundamental concepts of Probability theory and statistics.
2. Identify probability distributions encountered in real life situations and use the concepts of random variables to solve simple problems.
3. Apply appropriate statistical tools for analysing a specific set of data and relationship between two variables.
4. Conduct hypothesis tests and build confidence intervals to reach conclusions about population mean and standard deviation based on single set of data.

Unit – I	**10 Hrs**

Data Summary and Presentation: Tabular and Graphical display: Stem and Leaf diagrams, Histograms, Box plots, Radar diagrams.

Fundamentals of Probability Theory: Sample spaces and Events, Interpretations of probability, Addition rule, Conditional probability, Multiplication and Total probability rules, Independence, Bayes' theorem.

Unit – II	**10 Hrs**

Random Variables and Discrete probability Distributions: Random Variables, Discrete and continuous random variables. Probability distributions and mass functions, Expectations of random variables, Discrete uniform distribution, Binominal distribution, Poisson distribution, Applications.

Unit – III	**09 Hrs**

Continuous Probability Distributions: Continuous Uniform distribution, Normal distribution, Normal approximations, Exponential, Erlang, Gamma, Weibull distributions, Applications.

Unit – IV	**10 Hrs**

Joint Probability and Estimation theory: Marginal probability distributions, Independence, Covariance and correlation, Numerical Problems. Sampling distribution, Central Limit Theorem, Sampling distribution of means.

Unit – V	**09 Hrs**

Statistical Inference for a single sample: Hypothesis testing, Confidence intervals, Inference on the mean of a population (variance known and unknown), Inference on the variance of a normal population, Testing for Goodness of fit.

Course Outcomes:

After going through this course the student will be able to:

CO1: Understand the fundamental concepts of probability theory, statistics and commonly used probability distributions.

CO2: Identify joint distributions and calculate the different moments in addition to establishing goodness of fit.

CO3: Apply random phenomena, joint distribution and sampling theory to solve the problems in field of mechanical Engineering.

CO4: Analyze the physical problem to establish mathematical model and use appropriate method to solve

Reference Books:

1.	Douglas C Montgomery, George C Runger, "Applied statistics and Probability for Engineers", Wiley, Asia Student Edition, 4th Edition, 2007, ISBN: 978-81-265-2315-3.
2.	Richard I Levin, David S Rubin, "Statistics for Management", Prentice Hall India, 7th Edition, 1997, ISBN: 9780134762920.
3.	Walpole, Myers, Myers, Ye, "Probability and Statistics for Engineers and Scientists", Pearson Education Inc., 8th Edition, 2007, ISBN: 978-81-317-1552-9.
4.	Purna Chandra Biswal, "Probability and Statistics", PHI Learning Private Limited, Eastern Economy Edition, 2007, ISBN: 978-81-203-3140-2.

Scheme of Continuous Internal Evaluation (CIE):

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE):

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	L	H		L							
CO2		H	L	M							
CO3	M		L	M							
CO4		L		L				L			

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	L	L
CO2		M
CO3	M	
CO4	L	

INDUSTRIAL DESIGN AND ERGONOMICS (Theory and Practice)						
Course Code	**:**	**16MDP13**		**CIE Marks**	**:**	**100+50**
Hours /Week	**:**	**L:T:P:S**	**4:0:2:0**	**SEE Marks**	**:**	**100+50**
Credit	**:**	**5**		**SEE Duration**	**:**	**3+3 Hours**

Course Learning Objectives (CLO) :

Student shall be able to

1. Understand the importance of human factors in industrial design.
2. Analyze the effect of display size, shape, color and function in industrial products
3. Apply the concepts of interfacing man to machine in product design
4. Evaluate products for its function, ergonomics and aesthetics

Unit - I	**10Hrs**

Introduction: An approach to industrial design -elements of design structure for industrial design in engineering application in modern manufacturing systems.

Ergonomics and Industrial Design: Introduction -general approach to the man- machine relationship- workstation design-working position.

Unit -II	**10Hrs**

Control and Displays: Shapes and sizes of various controls and displays-multiple, displays and control situations - design of major controls in automobiles, machine tools etc., design of furniture -redesign of instruments.

Unit -III	**10Hrs**

Ergonomics and Production: ergonomics in automated systems, expert systems for ergonomic design. Anthropometric data and its applications in ergonomic, design- limitations of anthropometric data, use of computerized database. Case study

Unit-IV	**8Hrs**

Visual Effects of Line and Form: The mechanics of seeing- psychology of seeing general influences of line and form. **Color**: Color and light -color and objects- color and the eye - color consistency- color terms- reactions to color on engineering equipments.

Unit-V	**10Hrs**

Aesthetic Concepts: Concept of unity- concept of order with variety -concept of purpose style and environment. Aesthetic expressions. Style-components of style- house style, observation style in capital goods, case study.

Industrial Design in Practice: General design -specifying design equipments- rating the importance of industrial design -industrial design in the design process.

Unit-VI (Practice)

1. Fatigue measurement in human being using Blood pressure as parameter
2. Fatigue measurement in human being using SpO_2 as parameter
3. Fatigue measurement in human being using CO_2 as parameter
4. Measurement and analysis of anthropometric data in standing position.
5. Measurement and analysis of anthropometric data in sitting position.
6. Assessment of force exerted by human actuators
7. Operational Test using Sound level meter, Lux meter, Infrared thermometer in different work environments.
8. Evaluation of the effect of light intensity on human efficiency at work environment.
9. Experiments on cognitive ergonomics

10. Measurement of local muscle activity using EMG.

Course Outcomes:

After going through the course the students will be able to:

CO1. Explain the importance of ergonomics and aesthetics in industrial product design

CO2. Apply industrial design methodology while designing new products.

CO3. Analyze the man-machine interface and the effect of environment on working efficiency of human beings.

CO4. Design products with improved functions, ergonomics and aesthetics.

Reference Books

1. Mayall W.H., "Industrial Design for Engineers", London Hiffee Books Ltd., 1988, ISBN 978-1-118-02227-6.
2. Brain Shakel (Edited), "Applied Ergonomics Hand Book", Butterworth Scientific,1988. ISBN 123-1-118-027-6
3. R. C. Bridger, "Introduction to Ergonomics",McGraw Hill Publications, 1995, ISBN 215-8-02227-6.
4. Sanders & McCormick, "Human Factor Engineering", McGraw Hill Publications,6th edition, 2002, ISBN 815-118-02227-6.

Scheme of Continuous Internal Evaluation (CIE) for Theory

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Continuous Internal Evaluation (CIE) for Practical

CIE for the practical courses will be based on the performance of the student in the laboratory, every week. The laboratory records will be evaluated for 40 marks. One test will be conducted for 10 marks. The total marks for CIE (Practical) will be for 50 marks

Scheme of Semester End Examination (SEE) for Theory

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE) for Practical

SEE for the practical courses will be based on conducting the experiments and proper results for 40 marks and 10 marks for viva-voce. The total marks for SEE (Practical) will be 50 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	H	H	H	---	M	M	M	---	M	---	----
CO2	H	H	H	H	M	H	H	M	M	---	M
CO3	M	H	M	M	L	L	L	M	M	---	M
CO4	H	H	H	H	H	H	M	M	M	--	M

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	L
CO2	M	M
CO3	L	H
CO4	H	H

MATERIALS AND PROCESSES FOR DESIGN						
Course Code	**:**	**16MPD14**		**CIE Marks**	**:**	**100**
Hours /Week	**:**	**L:T:P:S**	**4:0:0:1**	**SEE Marks**	**:**	**100**
Credit	**:**	**5**		**SEE Duration**	**:**	**3 Hours**

Course Learning Objectives:

Student shall be able to

(1) Explain the properties of different materials and manufacturing process

(2) Apply the manufacturing process based on material and product

(3) Distinguish between the manufacturing processes for polymers, metals and ceramics

(4) Evaluate the design considerations based on material & process

Unit - I **10Hrs**

Thermoplastic Polymers & Its Manufacturing Processes

Polyethylene, Polypropylene, Polystyrene, Polyester, Polyvinyl Chloride, Acrylic,Polyamides, Polycarbonates, Review of Properties, Extrusion process, injection moulding process, compression moulding and blow moulding process, Applications of thermoplastics

Unit -II **10Hrs**

Thermoset Polymers & Manufacturing Processes for Composites

Epoxy resins, Polyester Resins, Vinyl Esters Resin, High Temperature Resin systems (PMR-15), Hand layup, Vacuum Baggging, Thermal Curing, Resin Transfer Mouding, Auto-Clave Filament winding and pultrusion Process

Micro & Macro Mechanical Analysis

Rule of mixture- density, Poisson ratio, Lateral and Longitudinal Modulus, Ultimate Tensile Strength, Compliance and Stiffness matrix for 2D lamina, and angle lamina, design considerations for selection of material and process, numerical

Unit -III **10Hrs**

Die Casting Processes

Die casting alloys, classification of castings, hot and cold chamber pressure die casting, investment casting, horizontal and vertical machines, feed system layout, Single and multicavity moulds, inspection of casting, defects in castings, numerical on mould design.

Powder Metallurgy Processes

Metallic powders – synthesis – ball milling, spray process, atomization, and characterization, preparation of green compact, pressureless and pressure-assisted sintering, finishing process, applications of PM, numerical on PM mould design,

Unit-IV **10Hrs**

Ceramic Materials & Processing Technologies

Ceramic materials - Silicate & Non-silicate Ceramics, Alumina, Zirconia; Pressing, casting, extrusion of ceramics, role of additives, industrial, domestic and medical applications of ceramics

Unit-V **9Hrs**

Materials & Process for Design

Introduction, Nature of the Selection Process, Analysis of the Material Performance Requirements and Creating Alternative Solutions, Initial Material Screening of Solutions, Comparing and Ranking Alternative Materials, Design Considerations for Cast Components,

Molded Plastic Components, Powder Metallurgy Parts, Detail Design and Selection of Materials and Processes.

Self study

The student will have to choose a topic of his/her interest within the scope of the course and pursue a study in that domain. This will be for 20 marks which will be evaluated in TWO phases by a committee consisting of two faculty members including the course faculty. The student has to demonstrate his/her capability of understanding, analyzing and applying the knowledge to solve problems. The study could be a theoretical one involving simulation and analysis or could be an experimental one or even involve building a prototype system.

Course Outcomes:

CO1: Explain the properties of different materials ,composites manufacturing processes.

CO2;Select the manufacturing process based on material and product

CO3:Distinguish between processes of design for polymers, metals and ceramics

CO4:Evaluate the design considerations based on material & process

Reference Books

(1) Autar Kaw, "Mechanics of Composite Materials", Taylor & Francis, ISBN 8870-1-118-02227-6.
(2) A K Sinha, "Powder Metallurgy", 2nd Edn, Dhanpath Rai Publications, ISBN 1-118-04527-6.
(3) Do Ehler H A, "Die Casting", McGraw Hill Publications, ISBN 1056-1-118-06.
(4) Phillippe Boch, "Ceramic Materials & Process", 2010, Wiley Publication, ISBN 1-118-02425-8

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE) The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1		M	M	H		H	L				
CO2	L		L				L		M		
CO3		M			M					L	
CO4	L	H	H	H		H	L		H		L

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1		M
CO2		L
CO3	M	
CO4	H	L

DESIGN FOR MANUFACTURE (Elective Group 1)						
Course Code	**:**	**16MPD151**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 Hours**

Course Learning Objectives (CLO):

Student shall be able to

1. Understand the concepts of Geometric dimensioning and Tolerances in Engineering drawing
2. Analyse the process capabilities and datum features in various components
3. Evaluate the design considerations of casting, injection moulding, die casting and powder metallurgical components
4. Estimate the assembly limits, machining sequence and process parameters

Unit – I	**10Hrs**

Selection of materials for processes: Introduction, Advantages of applying DFMA, General requirements of early materials and process selection, Selection of Manufacturing processes, Process capabilities, shape attributes, material selection by Membership function modification and dimensionless ranking, computer based primary process/material selection

Unit – II	**10Hrs**

Engineering Design features. – Dimensioning, General Tolerance, Assembly limits, achieving larger machining tolerances, Screw threads, Ground surfaces, holes. Problems. **Datum features** – Functional datum, Machining sequence, manufacturing datum, changing the datum. Examples

Unit – III	**10Hrs**

Component design – Casting Considerations – Pattern, Mould, parting line, cast holes, machined holes, identifying parting line, special sand cores, designing to obviate sand cores. Examples, **Design for Injection Molding –** Injection molding materials, Molding cycle, Systems, machine size, cycle time, cost estimation, Insert molding, Design guidelines

Unit – IV	**10Hrs**

Design for Die casting and Powder metal processing – Die casting alloys, cycle, machines, dies, finishing, Assembly techniques, Design principles, Powder metallurgy processing, stages, compaction characteristics, Tooling, Sintering, Design guidelines

Unit – V	**8Hrs**

GD&T – Symbols, Three datum concept of dimensioning, Straightness, concentricity, Run-out, Location Tolerance, Assembly of parts having concentric cylinders, Control of feature location by true position, Body of revolution, Roundness, Profile dimensioning, Tapers, Shaft of two diameters. Examples.

Course Outcomes:

After going through this course the student will be able to:

CO1: Explain the design principles related to various manufacturing processes and assembly methods

CO2: Apply the concepts of Geometrical dimensioning, selection of materials and tolerance for engineering products

CO3: Evaluate the assembly limits, general tolerances and process parameters CO4: Develop the appropriate material and machining sequence for manufacturing processes	
Reference Books:	
1.	Geoffrey Boothroyd, Peter Dewhurst, Winston Knight Marcel Dekker, Inc.,"Product Design for Manufacture and Assembly", –Newyork - Second Revision, ISBN 0-8247-0584-X
2.	Harry Peck," Designing for Manufacturing", Pitman Publications,1983, ISBN: 1-85233-810-5
3.	Merhyle F Spotts, Englewood Cliffs, **"**Dimensioning and Tolerance for Quantity Production**"** Prentice Hall, 5th edition, ISBN: 2-95433-956-3

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	H		H	M		H	L				
CO2		H	M	M			L	L	M		L
CO3		H	H	L	M			L		L	
CO4		M	H	H		H	L		H	M	L

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	**PSO2**
CO1		M
CO2		L
CO3	M	M
CO4	H	L

SIMULATION OF MANUFACTURING SYSTEMS
(Elective Group 1)

Course Code	**:**	**16MPD152**		**CIE Marks**	**:**	**100**
Hours /Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credit	**:**	**4**		**SEE Duration**	**:**	**3 Hours**

Course Learning Objectives:

Student shall be able to

1. Explain a given engineering system in terms of purpose, parameters, constraints, performance requirements, subsystems, interconnections and environmental context.
2. Analyse a modeling strategy for a real world engineering system byintegrating sub-system models.
3. Apply a model to facilitate engineering decision making and predicted advantages over alternative models.
4. Evaluate the simulation results of an engineering system model, within the context of its capabilities and limitations, to address critical issues in an engineering project

Unit - I	**10Hrs**

Principles of Computer Modeling And Simulation

Monte Carlo simulation. Nature of computer- modeling and simulation. Limitations of simulation, areas of applications.

System and Environment

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

Unit -II	**9Hrs**

Discrete Event Simulation

Concepts in discrete event simulation, manual simulation using event scheduling, single channel queue, two server queue , simulation of inventory problem.

Statistical Models in Simulation

Discrete distributions, continuous distributions.

Unit -III	**10Hrs**

Random Number Generation

Techniques for generating random numbers- Mid square method -the mod product method -Constant multiplier technique -Additive congruential method -Linear congruential method -Tests for random numbers -The Kolmogorov-Smirnov test -the Chi-square test.

Random Variable Generation

Inversion transforms technique-exponential distribution. uniform distribution, weibul distribution, continuous distribution, generating approximate normal variates-Erlang distribution.

Unit-IV	**10Hrs**

Empirical Discrete Distribution

Discrete uniform -distribution poisson distribution -geometric distribution - acceptance -rejection technique for Poisson distribution gamma distribution.

Unit-V	**10Hrs**

Design and Evaluation Of Simulation Experiments

variance reduction techniques -antithetic variables, variablesverification and validation of simulation models.

Course Outcomes:

After going through this course the student will be able to:

CO1. Explain elementary tools of modeling of mechanical, electrical, fluid, and thermo fluid Systems.

CO2. Discuss real-world systems to which modeling and analysis tools are applied.

CO3. Evaluate basic concepts in numerical integration and computer simulation of Mathematical models.

CO4:Apply decision-making skills needed to devise models that adequately represent relevant behaviors yet remain simple.

Reference Books

1. Jerry Banks & John S Carson II, "Discrete Event System Simulation" **,** Prentice Hall Inc.-1984., ISBN : 57:04577-02-0253
2. Gordan. G,"Systems Simulation", Prentice Hall India Ltd -1991, ISBN : 52: 02526820001
3. Nusing Deo ,"System Simulation With Digital Computer", Prentice Hall of India – 1979, ISBN : 42: 025268205011
4. Francis Neelamkovil, "Computer Simulation and Modeling", John Wilely& Sons -1987, ISBN : 57:04581-02-0235

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	M	M	H	H	L			M	M		L
CO2	M	H	H	H	L	L		L		M	L
CO3	H	M	M	L			M				H
CO4	L	H	L	M				L		L	

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	
CO2		L
CO3		M
CO4	M	

PROFESSIONAL SKILL DEVELOPMENT						
Course Code	**:**	**16HSS16**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L:T:P:S**	**0:0:4:0**	**Credits**	**:**	**02**

Course Learning Objectives:

Students are able to

1. Understand the importance of verbal and written communication
2. Improve qualitative and quantitative problem solving skills
3. Apply critical and logical think process to specific problems
4. Manage stress by applying stress management skills

UNIT 1	5 Hours

Communication Skills: Basics of Communication, Personal Skills & Presentation Skills, Attitudinal Development, Self Confidence, SWOC analysis.

Resume Writing: Understanding the basic essentials for a resume, Resume writing tips Guidelines for better presentation of facts.

UNIT 2	6 Hours

Quantitative Aptitude and Data Analysis*:* Number Systems, Math Vocabulary, fraction decimals, digit places etc. Reasoning and Logical Aptitude, - Introduction to puzzle and games organizing information, parts of an argument, common flaws, arguments and assumptions. Verbal Analogies – introduction to different question types – analogies, sentence completions, sentence corrections, antonyms/synonyms, vocabulary building etc. Reading Comprehension, Problem Solving

UNIT 3	4 Hours

Interview Skills: Questions asked & how to handle them, Body language in interview, Etiquette, Dress code in interview, Behavioral and technical interviews, Mock interviews - Mock interviews with different Panels. Practice on Stress Interviews, Technical Interviews, General HR interviews

UNIT 4	5 Hours

Interpersonal and Managerial Skills: Optimal co-existence, cultural sensitivity, gender sensitivity; capability and maturity model, decision making ability and analysis for brain storming; Group discussion and presentation skills;

UNIT 5	4 Hours

Motivation and Stress Management: Self motivation, group motivation, leadership abilities Stress clauses and stress busters to handle stress and de-stress; professional ethics, values to be practiced, standards and codes to be adopted as professional engineers in the society for various projects**.**

Note: The respective departments should discuss case studies and standards pertaining to their domain

Course Outcome:

After going through this course the students will be able to

CO1: Develop professional skill to suit the industry requirement

CO2: Analyze problems using quantitative and reasoning skills

CO3: Develop leadership and interpersonal working skills

CO4: Demonstrate verbal communication skills with appropriate body language.

References
1. Stephen R Covey, "The 7 Habits of Highly Effective People", Free Press, 2004 Edition, ISBN: 0743272455
2. Dale Carnegie, "How to win friends and influence people", General Press, 1st Edition, 2016, ISBN: 9789380914787
3. Kerry Patterson, Joseph Grenny, Ron Mcmillan, "Crucial Conversation: Tools for Talking When Stakes are High", McGraw-Hill Publication, 2012 Edition, ISBN: 9780071772204
4. Ethnus, "Aptimithra: Best Aptitude Book", Tata McGraw Hill, 2014 Edition, ISBN: 9781259058738

Scheme of Continuous Internal Examination (CIE)

Evaluation will be carried out in TWO Phases.

Phase	Activity	Weightage
I	After 7 weeks - Unit 1, 2 & Part of Unit 3	50%
II	After 12 weeks – Unit 3, 4, 5	50%

CIE Evaluation shall be done with weightage as follows:

Writing skills	10%
Logical Thinking	25%
Verbal Communication & Body Language	35%
Leadership and Interpersonal Skills	30%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	H	---	L	---	----	H	----	H	H	H	M
CO2	H	M	H	---	---	---	----	---	M	H	M
CO3	---	---	L	---	---	H	---	H	H	H	H
CO4	---	---	H	---	----	H	L	H	H	H	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	M	
CO2		L
CO3		L
CO4	H	

SECOND SEMESTER

RESEARCH METHODOLOGY						
Course Code	**:**	**16MEM21R**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L: T: P: S**	**3:2:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 Hours**

Course Learning Objectives:

Students are able to

1. Understand of the underlying principles of quantitative and qualitative research
2. Perform the gap analysis and identify the overall process of designing a research study.
3. Choose the most appropriate research methodology to address a particular research problem
4. Explain a range of quantitative and qualitative approaches to analyze data and suggest possible solutions.

Unit – I	**7 Hours**

Overview of Research

Meaning of Research, Types of Research, Research and Scientific Method, Defining the Research Problem, Research Design, Different Research Designs.

Unit – II	**7 Hours**

Methods of Data Collection

Collection of Primary Data, Observation Method, Interview Method, Collection of Data through Questionnaires, Collection of Data through Schedules, Collection of Secondary Data, Selection of Appropriate Method for Data Collection.

Unit – III	**8 Hours**

Sampling Methods

Sampling process, Non-probability sampling, probability sampling: simple random sampling, stratified sampling, cluster sampling systematic random sampling, Determination of sample size, simple numerical problems.

Unit – IV	**7 Hours**

Processing and analysis of Data

Processing Operations, Types of Analysis, Statistics in Research, Measures of: Central Tendency, Dispersion, Asymmetry and Relationship, correlation and regression, Testing of Hypotheses for single sampling: Parametric (t, z and F) Chi Square, ANOVA, and non-parametric tests, numerical problems.

Unit-V	**7 Hours**

Essential of Report writing and Ethical issues:

Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Precautions for Writing Research Reports.

Syllabus includes 12 hours of tutorials in which:

- Faculty is expected to discuss research methodology for specializations under consideration.
- Numerical problems on statistical analysis as required for the domains in which students are studying must be discussed.
- Statistical analysis using MINITAB/ MatLab and such other softwares can be introduced.

Course Outcomes:

After going through this course the students will be able to

CO 1. Explain various principles and concepts of research methodology.

CO 2. Apply appropriate method of data collection and analyze using statistical methods.

CO 3. Analyze research outputs in a structured manner and prepare report as per the technical and ethical standards.

CO 4. Formulate research methodology for a given engineering and management problem situation.

Reference Books:

1. Kothari C.R., "Research Methodology Methods and techniques", New Age International, 2004, ISBN: 9788122415223
2. Krishnaswami, K.N., Sivakumar, A. I. and Mathirajan, M., "Management Research Methodology", Pearson Education India, 2009 Edition, ISBN:9788177585636
3. Levin, R.I. and Rubin, D.S., "Statistics for Management", 7th Edition, Pearson Education: New Delhi, ISBN-13: 978-8177585841

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	M	---	---	M	----	----	---	H	---	H	-----
CO2	---	L	H	H	M	M	L	L	----	M	L
CO3	L	M	M	M	H	M	L	M	---	---	M
CO4	H	H	H	H	----	L	L	M	H	---	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	
CO2		L
CO3		H
CO4	L	

COMPUTER AIDED ENGINEERING (Theory and Practice)						
Course Code	**:**	**16MPD22**		**CIE Marks**	**:**	**100+50**
Hours /Week	**:**	**L:T:P:S**	**4:0:2:0**	**SEE Marks**	**:**	**100+50**
Credit	**:**	**5**		**SEE Duration**	**:**	**3 +3 Hours**

Course Learning Objectives:

Student shall be able to

(1) Understand the type of elements and boundary conditions for finite element analysis

(2) Identify 1-D and 2-D solutions for components such as bars, trusses, frames and beams

(3) Analyse the heat transfer, Eigen frequency and axismmetric problems

(4) Evaluate the components using ANSYS or equivalent software

PART A (Theory)

Unit – I **10Hrs**

Introduction: Need for numerical methods to solve engineering problems – mathematical modeling – discrete and continuum modeling — relevance and scope of finite element methods – engineering applications of FEA. Weighted residual methods – Rayleigh Ritz method – piecewise continuous trial functions – finite element method – application to bar element and beam elements, Numerical integration – Trapezoidal rule, Simpson's 1/3 rule, Newton-Cotes Formula, Gauss Quadrature formula, Gauss Quadrature in two and three dimensions

Unit -II **10Hrs**

One Dimensional Problems: Elemental equations for bar element, quadratic element, truss element, nodal approximation – development of shape functions – element matrices and vectors – example problems

Unit -III **10Hrs**

Two Dimensional Problems : Three noded triangular elements – four noded rectangular elements – higher order elements – generalized coordinates approach to nodal approximations, natural coordinates and coordinate transformations, iso-parametric, super-parametric, sub-parametric elements

Unit-IV **10Hrs**

Dynamic Problems : Formulation of dynamic problems, consistent and lumped mass matrices for bar and beam elements, Solution of eigenvalue problems – transformation methods, Jacobi method, Vector Iteration methods, subspace iteration method

Heat Transfer Problems: 1-D element, steady state heat transfer, one dimensional heat conduction, one dimensional heat transfer in thin fins, problems.

Unit-V **8Hrs**

Axisymmetric elasticity problems-Governing equations for axisymmetric elasticity, Axisymmetric linear triangular element, Axisymmetric four node iso-parametric element.

Beams and frames : Finite element formulation, shear and bending moment**,** plane frames, problems

PART B (Practical)
Part- I
Introduction to ANSYS, element library, applicability for engineering analysis, analysis of bars, trusses, beams and shafts, static analysis of 2D plates – subject to plane load, bending load and shells with internal pressure
Part-II
Dynamic and Thermal Analysis – Normal modal analysis of beams, bars and truss elements, harmonic analysis of beam structures, conductive, convective and radiative heat transfer problems, coupled field analysis
Course Outcomes: After going through this course the student will be able to CO1. Understand the fundamentals of finite element methods CO2. Develop the knowledge to analyse structures in static and dynamic conditions CO3. Assess the numerical techniques for solving engineering problems CO4. Formulate finite element model to implement industrial projects
Reference Books 1. Hutton, "Fundamentals of FEM", Tata McGraw Hill education Pvt. Ltd, 2005, ISBN: 0070601224 2. Daryl L Logan, "First Course in Finite element methods", 5th Edition, Thomson Brooks, 2011, ISBN : 10:0495668257 3.T R Chandrupatla, A D Belegondu, "Introduction to FE in engineering", 3rd Edition, Prentice Hall, 2004, ISBN: 4-44233-810-5

Scheme of Continuous Internal Evaluation (CIE) for Theory

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Continuous Internal Evaluation (CIE) for Practical

CIE for the practical courses will be based on the performance of the student in the laboratory, every week. The laboratory records will be evaluated for 40 marks. One test will be conducted for 10 marks. The total marks for CIE (Practical) will be for 50 marks.

Scheme of Semester End Examination (SEE) for Theory

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE) for Practical

SEE for the practical courses will be based on conducting the experiments and proper results for 40 marks and 10 marks for viva-voce. The total marks for SEE (Practical) will be 50 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	H	M		L			L			L	
CO2	M	H	H	M	L	L		L			
CO3	M	M	M			M		M	M	M	L
CO4			H	H	H			L		H	L

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	M
CO2	H	
CO3	M	M
CO4		L

DESIGN OF MOULDS AND DIES
(Elective Group 2)

Course Code	**:**	**16PDM231**		**CIE Marks**	**:**	100
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	100
Credits	**:**	**4**		**SEE Duration**	**:**	**3Hrs**

Course Learning Objectives (CLO)

Student should be able to

1. Understand the mechanics of the usual solutions to part demolding difficulties.
2. Identify the dimensions of the mold, runner system and clamping devices.
3. Analyse model of a mould showing the parting surfaces and respective 2D drawings.
4. Evaluate the effect of mould on the component.

Unit – I **9Hrs**

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.

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.

Unit – II **9Hrs**

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.

Moulds with External under Cuts: Split moulds, Actuation of splits, Guiding of splits, side cores

Unit – III **9Hrs**

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

Unit – IV **10Hrs**

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

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

Unit – V **10Hrs**

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, Moulds for threaded components, 3 Plate moulds, hot runner moulds, Multi-color moulding tools, Defects in moulding and its remedies, Compression moulding tools, transfer moulding tools

Course Outcomes:

After going through this course the student will be able to:

CO1 Understand the different Injection moulding, Extrusion, Lamination, Blow moulding and Special moulding technique.
CO2 : Analyse the plastic components, and challenges in selection of feed system, ejection, cooling and parting surface.
CO3: Apply the engineering knowledge for the selection of type of mould for plastic components.
CO4: Design and evaluate the effects of mould on the component.

Reference Books:

1. Pye. R,. G. W.New York ," Injection Mould Design", John Wiley & Sons, ISBN : 20:04523668257
2. Charles A. Harper , "Hand book of Plastic Processes" , ISBN 10:0495668257
3. Extrusion –Berln, ISBN : 60:06668957
4. Dallas B.Daniel, "Progressive Dies", Springer publication, 2005. ISBN 8:03953374987

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	L			H				M	M		
CO2										M	
CO3	M	M		H			M				L
CO4			M		H			L			

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	M	
CO2		L
CO3	M	
CO4	H	

DESIGN OF MACHINE TOOLS
(Elective Group 2)

Course Code	**:**	**16MPD232/16MCM 232**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 Hrs.**

Course Learning Objectives (CLO):

Student shall be able to

1. Understand the fundamentals of Machine Tool Design
2. Demonstrate the principles of Machine Tool Design concepts
3. Develop the Design Intricacies
4. Solve the design problems of Machine Tool
5. Apply the concepts to design the Machine Tool

Unit – I **08 Hrs**

INTRODUCTION: Working and Auxiliary Motion, Parameters Defining Working Motion Of Machine Tool, Machining time problems, Machine Tool Drives, Hydraulic Transmission And Its Elements, Mechanical Transmission And Its Elements, General Requirements, Layout Of Machine Tool, Aim of Speed and Feed Rate Regulation

Unit – II **10 Hrs**

REGULATION OF SPPED AND FEED RATES: Stepped Regulation of Speed, Design of Feed Box, Machine Tool Drives Using Multiple Speed Motors, Special Cases of Gear Box Design, Determining The Number of Teeth of Gears, Classification of Speed and Feed Boxes, Functions and Requirements

Unit – III **10 Hrs**

DESIGN OF MACHINE TOOL STRUCTURES: Design Criteria, Materials, Static Stiffness, Profile of Machine Tool Structures, Basic Design Procedure, Design of Beds, Design of Columns, Design of Housing, Design of Bases and Tables, Design of Cross Rails, Arms, Saddles, Carriages and Rams.

Unit – IV **10 Hrs**

DESIGN OF GUIDEWAYS AND POWER SCREWS: Function and Types Guideways, Design of Slideways, Design Criteria and Calculations Slideways, guideways operating under liquid friction conditions, Design of Power Screws.

Unit – V **10 Hrs**

DESIGN OF SPINDLES AND SPINDLE SUPPORTS: Functions of Spindles Unit and requirements, Materials of Spindles, Effect of Machine Tool Compliance on Machining accuracy, Design Calculation of Spindles, Anti-friction Bearings, Sliding Bearings.

Course Outcomes:

After going through this course the student will be able to:

CO1: Describe the fundamentals of Machine Tool Design
CO2: Analyze the merits and demerits of different machine tool design techniques
CO3: Apply the numerical equations in designing the Machine Tool
CO4: Demonstrate the designing skill of Machine Tool

Reference Books

1. N K Mehta, "Machine Tool Design and Numerical Control", Tata McGraw Hill, 3rd Ed, ISBN: 978-1-25-900457-5
2. N. Acherkan V Push, Nicholas Weinstein, "Machine Tool Design" University Press, 2000, ISBN: 9780898750485
3. Nicholas Lisitsyn, Alexander Gavryusin, Oleg Trifonov, Alexander Kudryashov, " Machine Tool Design" ,Ardent Media Inc. ISBN: 9780829014761
4. CMTI, "Machine Tool Design Handbook", Tata McGraw-Hill, 2008, ISBN: 978-0-07-451564-8

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	M	L	H								
CO2	M	M	L	M							
CO3		L	M	H	M						
CO4			L	M	H						

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	L	L
CO2	L	
CO3		M
CO4		H

PRODUCT COST ANALYSIS AND OPTIMIZATION
(Elective Group3)

Course Code	**:**	**16MPD241**		**CIE Marks**	**:**	**100**
Hours /Week	**:**	**L: T: P: S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credit	**:**	**4**		**SEE Duration**	**:**	**3 Hours**

Course Learning Objectives:

Student should be able to

(1) Understand the new product strategies in the product development

(2) Apply the appropriate technique for manufacturing and standardization of Manufacturing Planning

(3) Analyze the Cost calculation for machined components, welding, casting and forged components

(4) Evaluate the steps involved in cost estimation and Launching the product

10Hrs

Unit – I

Introduction: New products, New product strategy , Sequential Decision Process, Market definition and entry strategy, Idea generation, introduction to the design process, forecasting sales potential

Unit -II **10Hrs**

Consumer Measurement process, Research Methods, Sampling, Attitude Scaling,

Perceptual Mapping: Perceptual Positioning, Perceptual Maps and Analytical methods to Perceptual Maps Product Positioning : Preference in Product Positioning, Proactive Product Positioning, Benefit Segmentation, Managerial use of Preference Models

Unit -III **10Hrs**

Manufacturing Planning: Selection of optimum process, standardization. Break even analysis-application and area of use -problems -multi - product analysis and Process planning.

Value Analysis: Steps in selection, analysis and implementation, Selection of cutting speed for optimum cost - problems.

Unit-IV **10Hrs**

Cost Accounting

Cost estimation -difference -types -steps involved in cost estimation. Types of Cost: Cost Centres, Direct –indirect, material cost -direct indirect material cost Overhead cost

Elements in overheads: Preparation of cost sheet, machine hour rate, apportioning methods Variance Analysis – Labour variance, Material variance and Overhead variance, Activity based costing - Introduction to target costing

Unit-V **8Hrs**

Cost Calculation

Cost calculation for machined components, welding, casting, Sheet Metal and forged components illustrations - calculation of sales cost. Launching the product: Launch Planning, Track Launching, Durable and Industrial Products.

Course Outcomes:

After going through this course the student will be able to

CO1: Describe the Value Analysis and new product strategy

CO2: Apply suitable manufacturing process based on material and product

CO3: Analyzing the Cost Accounting machined components for a given material

CO4:Evaluate the parameters for design considerations based on process

Reference Books

(1) Glen L Urban, John R Hauser, " Design and Marketing of New Products", Prentice Hall. New Jersey, 1980, ISBN : 40:0257-02-0001

(2) T.R.Ranga and S C Sharma, " Mechanical Estimating and Costing",- Khanna Publishers-2015. ISBN : 40:0257-02-0001

(3) Yasuhiro Monden Cost management in the New Manufacturing Age -, Productivity Press-1992, 1980, ISBN : 90:0777-02-0001

(4) Miles Lewrence, " Technique for Value Analysis And Engineering", McGraw Hill, New york-1972, ISBN : 65:0257-22-0004

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1		H	M		H	M				H	L
CO2	H							M	L		
CO3		H		L							M
CO4	L		H		M		H				M

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	
CO2		M
CO3	M	
CO4	M	L

DESIGN FOR QUALITY
(Elective Group 3)

Course Code	**:**	**16MPD242**		**CIE Marks:**	**:**	**100**
Hours /Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credit	**:**	**4**		**SEE Duration**	**:**	**3Hours**

Course Learning Objectives

Student should be able to

1. Define a suitable process analytical tool for a given manufacturing environment.
2. Identify the tools for scientific process characterization
3. Apply basic risk analysis and experiment design techniques into practical cases
4. Evaluate the tools for risk management and Design of Experiments

Unit – I **9Hrs**

DESIGN FUNDAMENTALS, METHODS AND MATERIAL SELECTION

Morphology of Design – The Design Process – Computer Aided Engineering – Concurrent Engineering – Competition Bench Marking – Creativity – Theory of Problem solving - Value Analysis - Design for Manufacture, Design for Assembly – Design for casting, Forging, Metal Forming, Machining and Welding

Unit -II **9Hrs**

DESIGN FOR QUALITY

Quality Function Deployment -House of Quality-Objectives and functions-Targets-Stakeholders-Measures and Matrices-design process-Identification of control factors, noise factors, and performance metrics - developing the experimental plan. Running the experiments –Conducting the analysis-Selecting and conforming factor-Set points-reflecting and repeating

Unit -III **10Hrs**

DESIGN OF EXPERIMENTS: Importance of Experiments, Experimental Strategies, Basic principles of Design, Terminology, ANOVA, Steps in Experimentation, Sample size, Single Factor experiments - Completely Randomized design, Randomized Block design, Statistical Analysis, Multifactor experiments - Two and three factor full Factorial experiments, Fractional factorial design, Taguchi's approach - Steps in experimentation, Design using Orthogonal Arrays, Data Analysis, Robust Design- Control and Noise factors, S/N ratios

Unit-IV **10Hrs**

FAILURE MODE EFFECT ANALYSIS AND DESIGN FOR SIX SIGMA: **:** Design Failure Mode & Effect Analysis, Process Failure Mode & Effect Analysis, Product Reliability Analysis, Process capability analysis, Measurement system analysis. Basis of Six sigma –Project selection for Six sigma , six sigma problem solving- six sigma in service and small organization.

Unit-V **10Hrs**

STATISTICAL CONSIDERATION AND RELIABILITY Frequency distributions and Histograms- Run charts –stem and leaf plots- Pareto diagrams-Cause and Effect diagrams-Box plots- Probability distribution-Statistical Process control–Scatter diagrams –Multivariable charts –Matrix plots and 3-D plots.-Reliability-Survival and Failure-Series and parallel systems-Mean time between failure-Weibull distribution

Course Outcomes:

CO1. Describe suitable process analysis tools for a given manufacturing environment

CO2. Analyse and implement, from quality point of view, the basic design of experiments approach

CO3. Compare the critical quality attributes and critical process parameters

CO4. Develop Quality by design principles as a cost-efficient approach to delivering high quality products and services**.**

Reference Books

1. Dieter, George E, "Engineering Design- A Materials and Processing Approach", McGraw Hill International Editions, Singapore, , ISBN : 1:0337-32-0033
2. kevin otto & kristin wood, " Product Design Techniques in Reverse Engineering and New Product Development" , Pearson Education (LPE), ISBN : 56:0257-02-4501
3. James R. Evens, William M, " The Management and control of Quality",6th edition-Lindsay Publications, ISBN : 670:0257-02-0225
4. Glen L Urban, John R Hauser, " Design and Marketing of New Products", Prentice Hall. New Jersey, 1980, ISBN : 40:0257-02-0001

Scheme of Continuous Internal Evaluation (CIE)

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Scheme of Semester End Examination (SEE)

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Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	H	M					L				
CO2	M	M		L	L					L	
CO3	L		L	M	L					L	L
CO4	L	M				L		L	L		L

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	
CO2		M
CO3	M	M
CO4	L	

ADDITIVE MANUFACTURING (Elective Group4)						
Course Code	**:**	**16MPD251/16MTE251**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO):

Student shall be able to

1. Define the basics of Additive Manufacturing
2. Discuss the principles of Additive Manufacturing
3. Develop the concept of system and informatics of Additive Manufacturing
4. Evaluate the techniques of Additive Manufacturing
5. Apply AM science in implementing the Production Process

Unit – I	**10 Hrs**

Basic Principles and Development of AM Technology:
Conventional Machining Processes, Development of CAD/CAM systems, Advantages and Limitations; Concurrent Engineering; Data Format; Rapid Prototyping Technologies, Laminated Object Manufacturing

Unit – II	**10 Hrs**

Powder Bed Fusion Processes: Introduction, Materials, Powder Fusion Mechanisms, Process Parameters and Modeling, Laser, UV and IR; Process Benefits and Drawbacks.
Extrusion-Based Systems: Introduction, Basic Principles, Plotting and Path Control, Fused Deposition Modeling.

Unit – III	**10 Hrs**

Stereolithography: Materials, Processes parameters, advantages and limitations;
Material and Binder Jetting: Evolution, Materials, Material Processing Fundamentals, Material Jetting Machines, Process Benefits, binding materials and systems.
Laser Engineered Net Shaping (LENS) : Materials, Process Parameters & Systems
Post Processing of additive manufactured parts.

Unit – IV	**10 Hrs**

Design for Additive Manufacturing: Design for Manufacturing and Assembly, AM Unique Capabilities, Core DFAM Concepts and Objectives, CAD Tools for AM.
Applications for Additive Manufacture: Introduction, The Use of AM to Support Medical Applications, Aerospace and Automotive Applications.

Unit – V	**08 Hrs**

Rapid Tooling: Introduction, Direct and Indirect AM tooling process; Production of Injection Molding Inserts, EDM Electrodes, Investment Casting and Other Systems, RTV Silicone Tooling, Calcium silicate based castable tooling,

Course Outcomes:

After going through this course the student will be able to:

CO1 Explain the working process and technology development of Additive Manufacturing.
CO2 Apply the principles of AM in manufacturing industry
CO3 Analyze the concepts of AM in Production Process
CO4 Evaluating the techniques involved in AM

Reference Books:

1. Ian Gibson, David Rosen, Brent Stucker, "Additive Manufacturing Technologies"-Springer, 2nd Edition. ISBN 978-1-4939-2112-6
2. Chee Kai Chua, Kah Fai Leong, "3D Printing and Additive Manufacturing, Principles and Applications", 4th Ed, ISBN 978-9-8145-7140-1
3. Amit Bandyopadhyay, Susmita Bose " Additive Manufacturing", CRC Press 2015 ISBN 9781482223590
4. Lihni Wang, Andrew Y.C. Nee "Collabarative design and planning for digital manufacturing" Springer Series, 2009, ISBN 998-1-84882-286-3

Scheme of Continuous Internal Evaluation (CIE)

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Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	H	L									
CO2	M	M	L	M							
CO3	L	H	M	H	M						
CO4		L	L	M	H						

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	L	L
CO2		L
CO3	H	
CO4		H

OPTIMIZATION TECHNIQUES (Elective Group 4)						
Course Code	**:**	**16MPD252**		**CIE Marks**	**:**	**100**
Hours /Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credit	**:**	**4**		**SEE Duration**	**:**	**3 Hours**

Course Learning Objectives (CLO)

Student shall be able to

1. Understand the tools used in optimization technique
2. Analyse optimization algorithms, the theoretical principles that underpin them.
3. Apply specific methods to solve operations related problems
4. Develop modelling skills necessary to describe and formulate optimization problems and their use for solving several types of practically relevant optimization problems arising in process systems engineering

Unit - I	**10Hrs**

Classical Optimization Techniques: Introduction, Review of single and multivariable optimization methods with and without constraints, linear one-dimensional minimization problems, Examples

Unit -II	**10Hrs**

Nonlinear programming : Convex sets and convex functions, Kuhn-Tucker conditions. Convex quadratic programming: Wolfe's and Pivot complementary algorithms. Separable programming

Unit -III	**10Hrs**

Geometric Programming: Introduction, Unconstrained minimization problems, solution of unconstrained problem from arithmetic-geometric inequality point of view, Constrained minimization problems, Generalized polynomial optimization, Applications of geometric problems, Introduction to stochastic optimization

Unit-IV	**10Hrs**

Inventory Models: Introduction to inventory control, component inventory, dependent and indendent demand , inventory classification, deterministic inventory model, EOQ models with quantity discount.

Unit-V	**8Hrs**

Replacement & Maintenance Models: Replacement of items, subject to deterioration of items subject to random failure group vs. individual replacement policies. Master scheduling-objectives and methods

Course Outcomes:
after going through this course the student will be able to:
CO1. Describe different types of test of Hypotheses
CO2. Analyse various optimization techniques
CO3. Apply various multivariable optimization problems arising in process systems engineering
CO4. Evaluate the options of a particular method to achieve required operational goal.

Reference Books

1) Hiller and Liberman, "Introduction to Operations Research", McGraw Hill 8th Edn. 2008, ISBN: 9780070600928
(2) Taha.H.A,"Introduction to Operations Research", McMillan 7th Edn, 2006, ISBN: 8177585835
(3) Joseph G Monks, "Operations Management – Theory & Problems",McGraw Hill, 3rd Edn 1987, ISBN:0070427275
(4) Ramamurthy P," Production and Operations Management", 2nd Edn, New Age International, 2006, ISBN:812241558

Scheme of Continuous Internal Evaluation (CIE)
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Scheme of Semester End Examination (SEE)
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	M	H			L					L	L
CO2	M	H	L	L							
CO3						L	L				
CO4								M	L	M	

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1		M
CO2		L
CO3	M	
CO4	H	L

MINOR PROJECT						
Course Code	**:**	**16MPD26**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**0:0:10:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**05**		**SEE Duration**	**:**	**3 Hours**

Course Learning Objectives:

Students are able to

1. Understand the method of applying engineering knowledge to solve specific problems.
2. Apply engineering and management principles while executing the project
3. Demonstrate the skills for good presentation and technical report writing skills.
4. Identify and solve complex engineering problems using professionally prescribed standards.

GUIDELINES

1. Each project group will consist of maximum of two students.
2. Each student / group has to select a contemporary topic that will use the technical knowledge of their program of study after intensive literature survey.
3. Allocation of the guides preferably in accordance with the expertise of the faculty.
4. The number of projects that a faculty can guide would be limited to four.
5. The minor project would be performed in-house.
6. The implementation of the project must be preferably carried out using the resources available in the department/college.

Course Outcomes:

After going through this course the students will be able to

CO1: Conceptualize, design and implement solutions for specific problems.

CO2: Communicate the solutions through presentations and technical reports.

CO3: Apply resource managements skills for projects

CO4: Synthesize self-learning, team work and ethics.

Scheme of Continuous Internal Examination (CIE)

Evaluation will be carried out in THREE Phases. The evaluation committee will comprise of FOUR members : guide, two senior faculty members and Head of the Department.

Phase	Activity	Weightage

I	Synopsis submission, Preliminary seminar for the approval of selected topic and Objectives formulation	20%
II	Mid-term seminar to review the progress of the work and documentation	40%
III	Oral presentation, demonstration and submission of project report	40%

****Phase wise rubrics to be prepared by the respective departments**

CIE Evaluation shall be done with weightage / distribution as follows:

- Selection of the topic & formulation of objectives 10%
- Design and simulation/ algorithm development/experimental setup 25%
- Conducting experiments / implementation / testing 25%
- Demonstration & Presentation 15%
- Report writing 25%

Scheme for Semester End Evaluation (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

1. Brief write-up about the project 5%
2. Presentation / Demonstration of the project 20%
3. Methodology and Experimental Results & Discussion 25%
4. Report 20%
5. Viva Voce 30%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	M	M	H	H	H	---	---	M	---	H	H
CO2	----	---	----	---	H	----	---	H	H	H	----
CO3	H	H	M	---	M	M	H	H	---	M	H
CO4	---	H	----	---	----	H	M	M	M	H	---

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	**PSO2**
CO1	M	
CO2		L

CO3	M	
CO4	H	