G H Raisoni Institute of Engineering and Technology, Nagpur

(An Autonomous Institute affiliated to RTM Nagpur University, Nagpur)

Department of Mechanical Engineering

M. Tech. in CAD/CAM

PG Scheme & Curriculum - 2023 (NEP 2020)

Institute Vision and Mission

Vision

To achieve excellent standards of quality education by keeping pace with rapidly changing technologies and to create technical manpower of global standards with capabilities of accepting new challenges.

Mission

- Our efforts are dedicated to impart quality and value based education to raise satisfaction level of all stakeholders.
- Our Strength is directed to create competent professionals.
- Our endeavor is to provide all possible support to promote research and development activities.

Department Vision and Mission

Vision

To create excellence in the field of Mechanical Engineering by imparting quality education so as to develop our students to be capable of facing technology challenges.

Mission

- To adopt strict teaching learning monitoring system.
- Provide high quality, innovative and responsive education.

Program Educational Objectives

PEO1	**Preparation:** To prepare students to succeed in employment/profession and/or to pursue post graduate and research educations in Mechanical Engineering discipline in particular and allied Engineering discipline in general.
PEO2	**Core Competence:** To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to formulate, analyze and solve engineering problems requiring knowledge of Mechanical Engineering.
PEO3	**Breadth:** To prepare students with engineering breadth to innovate, design, and develop software products and to contribute in providing solutions related to multidisciplinary real life problems.
PEO4	**Professionalism:** To inculcate in students professional and ethical attitude, effective communication skills and team work to become a successful professional.
PEO5	**Learning Environment:** To provide students with an academic environment that makes them aware of excellence and lifelong learning in emerging technologies.

Program Specific Outcomes

PSO1	Apply knowledge in the field of Machine Design, Thermal and Manufacturing Engineering to solve engineering problems by utilizing advanced technology.
PSO2	Prepare students for successful careers in industry that meets the needs of Industries.
PSO3	Respond to the demand of the society by engaging in lifelong learning.

Program Outcomes

PO1	**Engineering knowledge:** Apply knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Scheme and Curriculum of M. Tech. CAD/CAM

Scheme Summary

Semester	Credits	Hours	Marks	No. of Theory Heads	No.of Practical Heads	Total Heads
I	22	26	625	5	4	9
II	22	26	625	5	4	9
III	12	24	200	-	1	1
IV	24	48	300	-	1	1
Total	**80**	**124**	**1750**	**10**	**10**	**20**

Course Category Credits Summary

Semester	No. of Credits for Course Category						Total
	Core (C)	Humanities (VAC+AEC)	Professional Skills (S)	Professional Electives (PE)	Open Electives (OE)	PROJECT/ INTRNSHIP (P)	
I	14	1	1	6	-	-	22
II	14	1	1	6	-	-	22
III	-	-	-	-	-	12	12
IV	-	-	-	-	-	24	24
Total	**28**	**2**	**2**	**12**	**-**	**36**	**80**

PG Scheme-2023 (NEP-2020)

M. Tech. in CAD/CAM

Subject Code	Name of Course	Course Category	Teaching Scheme				Credits	Evaluation Scheme					
								Theory			Practical		Total Marks
			L	T	P	Total Hrs.		TAE	CAE	ESE	INT	EXT	
SEMESTER-I													
23MTCADL439 23MTCADP439	Computer Graphics for CAD/CAM	PC	4	-	2	6	5	20	30	50	25	25	150
23MTCADL440 23MTCADP440	CNC & Robotics	PC	4	-	2	6	5	20	30	50	25	-	125
23MTCADL441	Computer Integrated Manufacturing	PC	4	-	-	4	4	20	30	50	-	-	100
23MTCADL4XX	Professional Elective-I	PE	3	-	-	3	3	20	30	50	-	-	100
23MTCADL4XX	Professional Elective- II	PE	3	-	-	3	3	20	30	50	-	-	100
23MTSHP602	Advanced Communication Skills	AEC	-	-	2	2	1	-	-	-	25	-	25
23MTCADP4XX	Professional Skill-I	S1	-	-	2	2	1	-	-		25	-	25
Total			**18**	**-**	**8**	**26**	**22**	**100**	**150**	**250**	**100**	**25**	**625**

Professional Elective –I	
23MTCADL442	Project Management and Finance
23MTCADL443	Total Quality Systems and Engineering
23MTCADL444	Data Structures & Algorithm
23MTCADL445	Artificial Intelligence and Expert systems

Professional Elective –II	
23MTCADL446	Product Data Management
23MTCADL447	Optimization Techniques
23MTCADL448	Design of Experiments
23MTCADL449	Vibration Analysis and Condition Monitoring

Professional Skill-I

23MTCADP450	Computational Fluid Dynamics
23MTCADP451	Design for Manufacturing & Assembly
23MTCADP452	Additive Manufacturing
23MTCADP453	Die, Mould and Tool Engineering

Subject Code	Name of Course	Course Category	Teaching Scheme				Credits	Evaluation Scheme					
								Theory			Practical		Total Marks
			L	T	P	Total Hrs.		TAE	CAE	ESE	INT	EXT	
SEMESTER-II													
23MTCADL547 23MTCADP547	Product Design and Development	PC	4	-	2	6	5	20	30	50	25	25	150
23MTCADL548 23MTCADP548	Finite Element Analysis	PC	4	-	2	6	5	20	30	50	25	-	125
23MTCADL555	Advanced Machine Design	PC	4	-	-	4	4	20	30	50	-	-	100
23MTCADL5XX	Professional Elective- III	PE	3	-	-	3	3	20	30	50	-	-	100
23MTCADL5XX	Professional Elective- IV	PE	3	-	-	3	3	20	30	50	-	-	100
23MTCADP403	Research Methodology and IPR	VAC	-	-	2	2	1	-	-	-	25	-	25
23MTCADP5XX	Professional Skill-II	S2	-	-	2	2	1	-	-	-	25	-	25
Total			**18**	**-**	**8**	**26**	**22**	**100**	**150**	**250**	**100**	**25**	**625**

Professional Elective –III	
23MTCADL549	Modeling and Simulation
23MTCADL550	Computational Methods for Design
23MTCADL551	Computer Aided Tool Design
23MTCADL553	Manufacturing System Integration and Management

Professional Elective –IV	
23MTCADL552	Plastics and Composites
23MTCADL556	Design of Piping System
23MTCADL557	Design of Material Handling System
23MTCADL554	Fracture Mechanics and Fatigue

Professional Skill-II

23MTCADP558	Introduction to Design Thinking
23MTCADP559	Programming for Problem Solving
23MTCADP560	Mechatronics, Robotics and Control
23MTCADP561	Product Innovation and Entrepreneurship

Subject Code	Name of Course	Course Category	Teaching Scheme				Credits	Evaluation Scheme					
								Theory			Practical		Total Marks
			L	T	P	Total Hrs.		TAE	CAE	ESE	INT	EXT	
SEMESTER-III													
23MTCADP632	Industry Project Dissertation/ Research (Phase I)	P	-	-	24	24	12	-	-	-	200	-	200
Total			**-**	**-**	**24**	**24**	**12**	**-**	**-**	**-**	**200**	**-**	**200**

Subject Code	Name of Course	Course Category	Teaching Scheme				Credits	Evaluation Scheme					
								Theory			Practical		Total
			L	T	P	Total Hrs.		TAE	CAE	ESE	INT	EXT	
SEMESTER-IV													
23MTCADP633	Industry Project Dissertation/ Research (Phase II)	P	-	-	48	48	24	-	-	-	150	150	300
Total			-	-	**48**	**48**	**24**	-	-	-	**150**	**150**	**300**
Total (I SEM to IV SEM)							**80**	**200**	**300**	**500**	**550**	**200**	**1750**

Professional Elective Courses

Course Code	Professional Electives-I (Semester-I) (Credits:3)	Course Code	Professional Electives-II (Semester-I) (Credits:3)	Course Code	Professional Electives-III (Semester-II) (Credits:3)	Course Code	Professional Electives-IV (Semester-II) (Credits:3)
Track-I		**Track-II**		**Track-III**		**Track-IV**	
23MTCADL442	Project Management and Finance	23MTCADL446	Product Data Management	23MTCADL549	Modeling and Simulation	23MTCADL552	Plastics and Composites
23MTCADL443	Total Quality Systems and Engineering	23MTCADL447	Optimization Techniques	23MTCADL550	Computational Methods for Design	23MTCADL556	Design of Piping System
23MTCADL444	Data Structures & Algorithm	23MTCADL448	Design of Experiments	23MTCADL551	Computer Aided Tool Design	23MTCADL557	Design of Material Handling System
23MTCADL445	Artificial Intelligence and Expert systems	23MTCADL449	Vibration Analysis and Condition Monitoring	23MTCADL553	Manufacturing System Integration and Management	23MTCADL554	Fracture Mechanics and Fatigue

Skill Category Courses

Semester	Course Code	Name of Course	Credit
I	23MTSHP602	Advance Communication Skills	1
I	23MTCADP4XX	Profession Skill-I	1
II	23MTCADP403	Research Methodology and IPR	1
II	23MTCADP5XX	Professional Skill-II	1

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Department of Mechanical Engineering
POST GRADUATE PROGRAMME
M. Tech. (CAD/CAM)
Syllabus

1st Semester

23MTCADL439/23MTCADP439: Computer Graphics for CAD/CAM											
Teaching Scheme				Credits	Evaluation Scheme						
					Theory				Practical		
L	T	P	Total Hours		TAE	CAE	ESE	Duration of ESE (Hrs.)	INT	EXT	Total Marks
4	-	2	6	5	20	30	50	3	25	25	150

Course Objectives	**1.** To understand the role of computer graphics in CAD/CAM and contemporary terminology, progress issues and trends in computer graphics. **2.** To understand the computer graphics techniques such as geometric transformations, geometric algorithms, 3D modeling, vector representation of geometric entities, 3D object models (surface, volume and implicit), visible surface algorithms**.** **3.** To study the 2D and 3D orthographic and perspective projection which is wide variety of applications and examples due the interdisciplinary nature of computer graphics
Course Outcomes	Upon successful completion of the course, students will be able to: **1.** Demonstrate an understanding of contemporary graphics hardware **2.** Create interactive graphics applications in C++ using one or more graphics application programming interfaces **3.** Write program functions to implement graphics primitives **4.** Write programs that demonstrate geometrical transformations

Course Contents:

Unit	Contents	Hours
I	Role of computer graphics in CAD/CAM, fundamentals of 2D graphics, menu design and Graphical User Interfaces (GUI), customization and parametric programming.	7
II	Vector representation of geometric entities, lines, circle, arc, conics, homogeneous coordinate systems, geometric transformations, 2D and 3D, orthographic and perspective projection, hidden line removal algos.	9
III	Planar and space curve design, analytical and synthetic approaches, parametric and implicit equations. surface of revolution, sweep surfaces, ruled and developable surfaces	8
IV	Modeling of bi parametric freeform surfaces, Coons, Bezier, B-spline, Rational B-Splines and NURBS surface patches, surface manipulation techniques, geometric modeling techniques, wireframe modeling. Solid modeling, B-Rep, CSG and hybrid	8

	modelers, feature based parametric and variational modeling.	
V	Introduction to product data standards and data structures, data-base integration for CIM.	6

Text books/Reference books	1. Faux, I.D. and Pratt, M.J., 'Computational Geometry for Design and Manufacture', John Wiley & Sons, NY, 1979 2. Mortenson, M.E., 'Geometric Modelling', John Wiley & Sons, NY, 1985. 3. Choi, B.K., 'Surface Modeling for CAD/CAM', John Wiley & Sons, NY, 1991 4. Martti Mantilya, 'An Introduction to Solid Modeling', Computer Science Press 5. Ibrahim Zeid, 'CAD/CAM', TMH 6. Rogers D F I and Adams J A, 'Mathematical Elements for Computer Graphics', McGraw-Hill, 1996 7. Multineux, 'CAD -Computational Concepts and Methods', Kogan Page Ltd, 1984 8. Ding Q. and Davies B. J. , 'Surface Engineering Geometry for Computer-Aided Design and Manufacture, Ellis Horwood, 1987 9. Hiroaki C., 'Solid Modelling with Design Base', Addison Wesley Publishing Co., 1998 10. Hoschek J., Dieter L., 'Fundamentals of Computer Aided Geometric Design', A K Peters, 1997.

Sr. No.	**Name of Experiment**	**Mapping With CO**
1	Programs for generation of entities like Line, Circle, Ellipse using Bressenham's algorithms.	CO 2
2	Programs for 2-D & 3-D transformations.	CO4
3	2-D Geometric modeling of an Engineering object, demonstrating Boolean operations like add, subtract and PAN, ZOOM, ROTATE commands	CO1
4	3-D Geometric Modeling of an Engineering object, demonstrating extrude, revolve and loft commands.	CO3
5	Generation of at least two simple solid models showing geometric properties using any CAD software.	CO3
6	Generation of any Assembly model along with animation.	CO1
7	Program for synthetic Curve generation like Bezier, spline etc.	CO 2
8	Program for generation of surface.	CO 2

23MTCADL440/23MTCADP440- CNC & Robotics

Teaching Scheme				**Credits**	**Evaluation Scheme**						
					Theory				**Practical**		**Total Marks**
L	**T**	**P**	**Total Hours**		**TAE**	**CAE**	**ESE**	**Duration of ESE (Hrs.)**	**INT**	**EXT**	
4	-	2	6	5	20	30	50	3	25	-	125

Course Objectives	1. To understand constructional details and operations of CNC lathe and milling as well as part programming. 2. To learn about working of Wire EDM machine. 3. To enable learning about constructional and operational details of robotics as well as programming.
	After successfully completing the course students will be able to: 1. Work with CNC lathe, milling, wire EDM machines and machining center.

Course Outcomes	2. Write programmes using manual part programming technique and APT for CNC lathe and milling machine. 3. Select appropriate robot for the given application. 4. Integrate the CNC machines with robot.

Course content:

Unit	Contents	Hours
I	Concepts of NC, CNC, DNC, classification of CNC machines, machine configurations, types of control, CNC controller's characteristics, interpolators. Cutting tool materials, carbide inserts classification; qualified semi qualified and preset tooling, tooling system for machining center and turning center, work holding devices, of CNC Machines.	7
II	Programming CNC machines, part print analysis and process planning, advanced programming features, canned cycles, subroutines, macros, special cycles etc, APT part programming using CAD/CAM, parametric programming, manual part programming for CNC turning, milling and machining center.	8
III	Wire EDM machines, computer assisted part programming techniques, conversational and graphics based software, solids based part programming. freeform surface machining, simulation and verification of CNC programs, adaptive CNC control techniques, integration of CNC machines for CIM, robotics - basic concepts, robot configurations , basic robot motions, types of drives, applications	7
IV	Transformations and kinematics, vector operations, translational transformations and rotational transformations, properties of transformation matrices, homogeneous transformations and manipulator, forward solution, inverse solution. controls and end effectors, control system concepts , analysis, control of joints, adaptive and optimal control end effectors, classification, mechanical, magnetic, vacuum, adhesive, drive systems and gripper design**.**	8
V	Robot programming, methods, languages, computer control and robot software – programming languages, sensory devices, non-optical and optical position sensors, velocity and acceleration, range, proximity, touch, slip, force, torque, machine vision, image components, representation, hardware, picture coding, object recognition and categorization, integration of robots with CNC machines for CIM.	8

Text /Reference books	1. Krar, S., and Gill, A., 'CNC Technology and Programming', McGraw Hill publ Co, 1990. 2. Gibbs, D., 'An Introduction to CNC Machining', Casell, 1987. 3.Seames, W.S., 'Computer Numerical Control Concepts and Programming', Delmar Publishers, 1986. 4. Lynch, M., 'Computer Numerical Control for Machining', McGraw Hill, 1992. 5. Koren Y., 'Computer Control of Manufacturing Systems', McGraw, 1986

Sr. No.	Name of Experiment	Mapping With CO
1	To Study detail introduction to Concepts of NC, CNC, DNC. Classification of CNC machines, Machine configurations, Types of control, CNC controllers characteristics, Interpolators	CO 1
2	To write a part programming and operation of a turning center	CO 2
3	To write a part programming and operations of a milling machine.	CO 2

4	To write a Manual part program by using Sub routing and canned cycle.	CO 2
5	To write a program in APT based NC programming languages	CO 2
6	To Study Fundamental of robot, anatomy, configuration, control, sensor, and gripper.	CO 3
7	To Practice in robot programming and its languages	CO 3
8	To prepare various reports and route sheets.	CO 4
9	To Study at least two application of robot	CO 4

23MTCADL441 – Computer Integrated Manufacturing

Teaching Scheme				Credits	Evaluation Scheme						
					Theory				Practical		
L	T	P	Total Hours		TAE	CAE	ESE	Duration of ESE (Hrs.)	INT	EXT	Total Marks
4	-	-	4	4	20	30	50	3	-	-	100

Course Objectives	1. To learn different types of manufacturing systems, in particular the manufacturing cell and the flexible manufacturing systems (FMS). 2. To learn the basics of computer assisted numerical control programming and programming languages. 3. To learn the concepts of computer integrated manufacturing and management system, automated flow lines and common CAD/CAM data base. 4. To learn using automated material handling, inspection and quality control systems in manufacturing. 5. To learn criteria required for implementing CAD/CAM systems and use associated software for design and manufacturing.
Course Outcomes	On completion of the course, the student will be able to: 1. Design, develop, select and integrate process equipment for flexible manufacturing and computer integrated manufacturing systems. 2. Develop high technology manufacturing systems based on common data bases. 3. Develop process planning under diverse manufacturing situations. 4. Identify and develop control systems for implementing production plans.

Course content:

Unit	Contents	Hours
I	Concept and scope of CIM, components of CIM, benefits, limitations, introduction to Group Technology, limitations of traditional manufacturing systems, characteristics and design of groups, benefits of GT and issues in GT, part families, classification and coding, production flow analysis, machine cell design, benefits.	7
II	Introduction & components of FMS, application work stations, computer control and functions, planning, scheduling and control of FMS, scheduling, knowledge based scheduling, hierarchy of computer control, supervisory computer, manufacturing data systems, data flow, CAD/CAM considerations, planning FMS database.	8

III	Automated material handling systems, AS/RS, general considerations, selection, evaluation and control, inspection and quality control, CAQC, CMM types, working, applications.	7
IV	Process planning in the manufacturing cycle, Process planning and production planning, process planning and concurrent engineering, CAPP, variant process planning, generative approach, forward and backward planning, input format, logical design of a process planning, Implementation considerations, manufacturing system components.	8
V	Overview of rapid product development, product developing cycle, definition of rapid product development, virtual prototypical and rapid manufacturing technologies, physical prototyping & rapid manufacturing technologies-synergic integration technologies, other rapid prototyping technologies such as three dimensional printing (3DP), solid based, liquid based and powder based 3DP systems.	8

Text /Reference books	1. Nanua Singh, 'Systems Approach to Computer Integrated Design and Manufacturing', John Wiley & Sons, 1996. 2. Groover M.P., 'Automation, Production Systems and Computer Integrated Manufacturing', Prentice-Hall of India Pvt. Ltd., New Delhi, 2002 3. Jha, N.K., 'Handbook of Flexible Manufacturing Systems', Academic Press Inc., 1991. 4. Burbidge, J.L., 'Group Technology in Engineering Industry', Mechanical Engineering pub. London, 1979. 5. Askin, R.G. and Vakharia, A.J., 'G.T Planning and Operation in The automated factory-HandBook: Technology and Management, Cleland, D.I. and Bidananda, B (Eds), TAB Books, NY, 1991. 6. Irani, S.A., 'Cellular Manufacturing Systems', Hand Book. 7. Kamrani, A.K, Parsaei, H.R and Liles, D.H. (Eds), 'Planning, Design and Analysis of Cellular Manufacturing Systems', Elsevier, 1995. 8. Gideon Halevi and Roland D. Weill, 'Principles of Process Planning - A Logical Approach', Chapman & Hall, 1995.

23MTCADL442 - Project Management & Finance

Teaching Scheme				Credits	Evaluation Scheme						
					Theory				Practical		
L	T	P	Total Hours		TAE	CAE	ESE	Duration of ESE (Hrs.)	INT	EXT	Total Marks
3	-	-	3	3	20	30	50	3	-	-	100

Course Objectives	1. To obtain an understanding and ability to use basic business financial management concepts in the context of project execution. 2. To understand capital budgeting, cost of capital, capital structure and resource allocation. 3. To be able to analyse and periodically monitor financial performance of project. 4. To apply financial leveraging for short term and long term financial policies for business and relate capital investment decisions and financial policies to business valuations.

Course Outcomes	After successful completion of this course the students will be able to: 1. Develop understanding and ability to use basic business financial management concepts in the context of project execution. 2. Prepare capital budget, estimate cost of capital, develop capital structure and allocate resources. 3. Analyse and periodically monitor financial performance of project. 4. Understand short term and long term financial policies for business and relate capital investment decisions to project performance.

Course content:

Unit	Contents	Hours
I	Project Management Concepts - Characteristics of a project need for project management, roles of project managers, project planning: statement of work (SOW) and overall project goals, work breakdown structure (WBS), preparation of task-flow network, CPM-PERT, Gantt chart, schedule the completion of all work elements, planning project communication, quality planning.	8
II	Cost Estimating and Budgeting - Preparing cost estimates, budgets and expenditures, effort and time estimation, developing cost summaries for tracking project expenditures, developing cost forecasts to proactively control future planned expenditures, resource allocation - identifying resource requirement, scheduling resources, analyze optimal labor utilization for cost effectiveness and schedule efficiency.	8
III	Project Performance Measurement and Control - Concept of earned value performance measurement, use of Project Management Information Systems (PMIS) to monitor, evaluate, and control planned cost and schedule performance, conducting periodic project performance evaluation audits.	8
IV	Project Evaluation and Termination - Analyzing project performances versus cost and schedule constraints, identify causes associated with project success and failure, ways in which a project can be terminated upon completion.	8
V	Concept of Business Finance - Finance function & scope in organization, responsibilities of finance executive, goals & objectives of financial management, functional areas, long term sources of financing : shares, debentures, term loans, lease & hire purchase, retained earnings, public deposits, bonds (types, features & utility), short term sources of financing: bank finance, commercial paper & trade credit & bills discounting internal: retained earnings, depreciation policies.	8

Text /Reference books	1. Meredith and Mantel, 'Project Management - A Managerial Approach', John Wiley and Sons, Fifth Edition, 2003. Course Text. 2. J. Davidson Frame, 'The New Project Management', Jossey-Bass, 1994. 3. Harold Kerzner, 'Project Management', Van Nostrand Reinhold, 1979. 4. Milton D. Rosenau, 'Successful Project Management', Lifelong Learning, 1981. 5. Ravi Kishore, 'Financial Management', Taxmann's. 6. S. M. Inamdar, 'Financial Management', Everest Publishing house, 12th Edition 2004 7. Sharma & Gupta , 'Financial Management', Kalyani Publishers 8. P. Shah, 'Financial Accounting for Management', Published by Oxford

23MTCADL443: Total Quality System & Engineering

Teaching Scheme				Credits	Evaluation Scheme						
					Theory				Practical		
L	T	P	Total Hours		TAE	CAE	ESE	Duration of ESE (Hrs.)	INT	EXT	Total Marks
3	-	-	3	3	20	30	50	3	-	-	100

Course Objectives	**1.** To study the significance and meaning of quality in changing business environment. 2. To study acceptance sampling and different statistical quality control tools and techniques. 3. To understand TQM, quality cost concepts and application of different Japanese management approaches for improving productivity and quality. 4. To understand ISO 9000 and others quality systems for world competitiveness.
Course Outcomes	Upon successful completion of the course, students will be able to: 1. Apply concepts of quality management to manufacturing operations and use various quality and productivity improvement techniques 2. Implement QFD, quality circles, Kaizen and similar concepts in maintaining and improving quality of manufacturing systems. 3. Use statistical techniques and acceptance sampling for controlling manufacturing processes and quality of products.

Course content:

Unit	Contents	Hours
I	Customer focus, principles of quality management, pioneers of quality, quality assurance, core concepts of TQM, quality costs, quality system, quality planning, benchmarking, re-engineering, business leadership, quality & productivity inter-relations.	8
II	Organization structure for managing quality, information systems and documentation, quality auditing, ISO 9000 - QS 9000, QMS, quality awards	7
III	Cutting the cost of quality, single vendor concept, just in time, lean and agile manufacturing, quality function deployment, quality circles, Kaizen, Pokayoke, quality engineering, Taguchi methods	8
IV	Methods and philosophy of statistical process control, process capability analysis, control charts for variables and attributes, special adaptations and varieties of control charts and SPC techniques, organized problem solving, quality improvement tools	7
V	Acceptance sampling, operating characteristic curve, AOQ, single, double and multiple sampling plans for attributes, sequential sampling, and six sigma manufacturing concepts	7

Text /Reference books	1. Mohamed Zairi, 'Total Quality Management for Engineers', Woodhead Publishing Limited 1991. 2. Harvid Noori and Russel, 'Production and Operations Management - Total Quality and Responsiveness', McGraw-Hill Inc, 1995. 3. N. Logothetis, 'Managing for Total Quality', Prentice Hall of India Pvt .Ltd, 1998 4. John Bank, 'The Essence of Total Quality Management', Prentice Hall of India Pvt. Ltd., 1995. 5. Douglus C. Montgomery, 'Introduction to Statistical Quality Control', 2nd Edition, John Wiley and Sons, 1991. 6. Grant E.L and Leavensworth, 'Statistical Quality Control', McGraw-Hill, 1984.

23MTCADL444 - Data Structures & Algorithm

Teaching Scheme				Credits	Evaluation Scheme						
					Theory				Practical		
L	T	P	Total Hours		TAE	CAE	ESE	Duration of ESE (Hrs.)	INT	EXT	Total Marks
3	-	-	3	3	20	30	50	3	-	-	100

Course Objectives	1. To understand the different methods of organizing large amounts of data. 2. To learn the systematic ways of solving data based problems. 3. To learn to programming in C. 4. To implement the different data structures efficiently. 5. To solve specific problems using stack, queue, link list and graphs.
Course Outcomes	Upon successful completion of the course, students will be able to: 1. Understand the basics of data structures 2. Identify structures and their implementation for handling large amount of data. 3. Develop an appropriate data structure for analysis and applications to problem solving 4. Understand advanced techniques for sorting and searching data efficiently

Course content:

Unit	Contents	Hours
I	Review of basic concepts of OOPs, objects, classes, polymorphism, inheritance, application in CAD/CAM codes. Introduction to data structures, abstract data types, array as an ADT, using one dimensional arrays, arrays as parameters, character string operations, multidimensional arrays.	8
II	Structures and classes, stack and its application, definition and examples, primitive operations, recursion, Fibonacci sequence, binary search, recursive chains, recursive definition of algebraic expressions, queues and lists, the queues representation insert operation, priority queue, array implementation of a priority queue.	8
III	Linked lists, inserting and removing nodes from a list, linked implementation of stacks, linked implementation of queues, linked list as a data structure, non integer and non homogeneous lists, dynamic and array implementation of lists, simulation using linked lists simulation process, data structures, other list structures, circular lists, doubly linked lists , multiple linked lists.	8
IV	Trees, binary trees operations, applications, representations of binary tree, internal and external nodes, implicit array representation of binary trees, choosing a binary tree representation, binary tree traversals, heterogeneous binary trees, sorting, efficiency considerations, o notation, efficiency of sorting, exchange sorts, bubble sort, quick sort, selection and tree sorting, straight selection sort, binary tree sorts, heap sort, insertion sorts, simple insertion, shell sort	8
V	Searching, basic search techniques, algorithmic notation, sequential searching, reordering a list searching an ordered table, indexed sequential search, binary search, interpolation search, tree searching, inserting/deleting in a binary search tree	8

Text /Reference books	1. Langsam Y., Augenstein M. J. & Tenenbaum A. M., 'Data Structures Using C and C++', Prentice Hall of India Pvt. Ltd. 2. Trembly J. P. & Sorenson P. G., 'An Introduction to Data Structures with Applications', Tata McGraw Hill Pub. Co. Ltd. 3. Horowitz E. & Sahani S., 'Fundamentals of Computer Algorithms', Galgotia Publications Ltd

23MTCADL445 - Artificial Intelligence and Expert Systems

Teaching Scheme				Credits	Evaluation Scheme						
					Theory				Practical		
L	T	P	Total Hours		TAE	CAE	ESE	Duration of ESE (Hrs.)	INT	EXT	Total Marks
3	-	-	3	3	20	30	50	3	-	-	100

Course Objectives	1. To study, analyze and simulate different AI techniques, different expert systems, etc. 2. To develop the concepts of AI in real life applications. 3. To study the use of artificial intelligence in machine through the natural language programming. 4. To study the architecture of expert systems and understand the knowledge rule based systems in AI. 5.To learn OOPs in expert system
Course Outcomes	Upon successful completion of the course, students will be able to: 1. Apply the basics of AI and expert system to analyze practical problems. 2. Select appropriate AI & expert systems and tools for solving real life problems and their analysis. 3. Understand advanced computing techniques that would help in further research and development.

Course content:

Unit	Contents	Hours
I	Human and machine intelligence, artificial intelligence (AI), programming in AI environment, natural language processing (NLP), architecture of an expert system.	7
II	knowledge base, inference engine forward and backward chaining, use of probability and fuzzy logic, selection of inference mechanism, semantic nets, structure and objects, ruled systems for semantic nets, certainty factors, automated learning.	8
III	Introduction to rule based system, conflict resolution, advantages and drawbacks of rule based systems clausal form logic; rule base verification, refinement and validation creating knowledge base, knowledge engineer and domain expert, phases of knowledge engineering, tools for knowledge engineering	9
IV	Neural network applications, artificial neural network models, NN applications in cellular manufacturing and other areas of mechanical engineering	8
V	Fundamentals of OOP (Object Oriented Programming), creating structures and objects, object operations, invoking procedures, programming applications, object oriented expert systems.	7

Text /Reference books	1. Addis, T.R., 'Designing Knowledge Based System', Prentice Hall, 1985. 2. Rolston, D.W., 'Principles of Artificial Intelligence and Expert Systems Development', McGraw Hill, 1988. 3. Maus, R. and Keyes, J., 'Handbook of Expert Systems in Manufacturing', McGraw Hill, 1991 4. Robert Levine, 'A comprehensive guide to artificial intelligence and expert systems', 5. Elain Rich , 'Artificial Intelligence', PHI Publication 6. Sasikumar, Ramani, et al , 'Rule based expert systems'. 7. Graham Winstanley, 'Program Design for Knowledge Based Systems', Galgotia Publications. 8.Zurada, 'Artificial Neural Networks'

23MTCADL446: Product Data Management

Teaching Scheme				Credits	Evaluation Scheme						
					Theory				Practical		
L	T	P	Total Hours		TAE	CAE	ESE	Duration of ESE (Hrs.)	INT	EXT	Total Marks
3	-	-	3	3	20	30	50	3	-	-	100

Course Objectives	1. To introduce general idea of database management system. 2. To develop skills to design databases using data modeling and design techniques. 3. To develop skills to implement real life applications which involve database handling. 4. Enable exploring opportunities in designing, storage techniques and data handling and managing techniques
Course Outcomes	Upon successful completion of the course, students will be able to: 1. Understand basics of data base management system 2. Identify data models and design techniques involved in the database design process 3. Develop applications for handling data in real life applications. 4. Understand advanced storage methods, indexing techniques, optimization techniques, transaction management processes in database handling.

Course content:

Unit	Contents	Hours
I	Purpose of database systems, view of data, data models, database languages, database users, overall system structure design issues, mapping constraints, keys, entity-relationship diagram, weak entity sets, extended E-R features, design of an E-R database schema	7
II	Structure of relational databases, the relational algebra, tupple relational calculus, the domain relational calculus, extended relational algebra operations, modifications of database, views, basic structure, set operations, aggregate functions, null values, nested sub queries, derived relations, views	7
III	Modification of the database, joined relations, data-definition language, other relational languages, query by example, quell, data log, views domain constraints, referential integrity, assertions, triggers, functional dependencies views, pitfalls in relational-database design, decomposition, normalization using functional dependencies, views.	8
IV	Enterprise Resource Planning: An overview, enterprise – an overview, benefits of ERP, ERP and related technologies, business process reengineering (BPR), implementation lifecycle, implementation methodology, project management and monitoring business modules in an ERP Package: finance, manufacturing, human resources, plant maintenance, materials management, quality management, sales and distribution.	8
V	Fundamentals of PLM, enterprise solution with PLM, impact of manufacturing with PLM, standardized product data and materials data model, PLM service information model, PLM for e-manufacturing, product design databases, CAD-CAM data management requirements, databases for shop floor control and factory information system, database requirements of computer integrated manufacturing, views.	8

Text /Reference books	1.Abraham Silber Schatz, Henry F. Korth, S. Sudarshan, 'Database System Concepts', McGraw Hill International Editions, Third Edition 2.P. Beynon-Davies, 'Expert Database Systems – A Gentle Introduction', McGraw Hill International; 1991 3.James Martin, 'Database Management Systems' 4.Fredrick H. Jones and Lloyd Martin, 'The AutoCAD Database Book – Accessing and Managing CAD Drawing Information', Galgotia Publications, Third Edition

23MTCADL447 - Optimization Techniques

Teaching Scheme				Credits	Evaluation Scheme						
					Theory				Practical		
L	T	P	Total Hours		TAE	CAE	ESE	Duration of ESE (Hrs.)	INT	EXT	Total Marks
3	-	-	3	3	20	30	50	3	-	-	100

Course Objectives	1. To introduce methods of optimization including linear programming and simplex method. 2. To understand different one variable and unconstrained optimization techniques. 3. To learn different direct and indirect methods of optimization under constraints such as random search, sequential linear programming, penalty function method and the augmented Lagrange multiplier method.
Course Outcomes	Upon successful completion of the course, students will be able to: 1. Apply linear programming, simplex method and other tools of optimization. 2. Apply different one variable and unconstrained optimization techniques to engineering systems. 3.Use different direct and indirect methods of optimization under constraints

Course content:

Unit	Contents	Hours
I	Basic Concepts: Introduction, optimization concepts, general problem statement, classification of optimization problems, optimization techniques linear programming: introduction, standard linear programming form, possible solutions, the Simplex method, revised Simplex method, duality in linear programming, sensitivity analysis	8
II	One Variable Optimization: Introduction, search methods, polynomial approximations, golden section method, other methods, comparison of the methods	7
III	Unconstrained Optimization Techniques: Introduction, zero-order methods, first-order methods, second-order methods, convergence criteria	8
IV	Constrained Optimization Techniques: Direct methods, introduction, random search, sequential linear programming, the method of feasible directions, generalized reduced gradient method, sequential quadratic programming, indirect methods: introduction, the exterior penalty function method, the interior penalty function method, the extended interior penalty function method, the augmented Lagrange multiplier method.	8

V	Further Topics in Optimization: Structural optimization, multi objective optimization, genetic algorithms.	7

Text /Reference books	1. S. S. Rao, 'Engineering Optimization', New Age International 2. E. J. Haugand J.S. Arora, 'Applied Optimal Design', Wiley, New York 3. K. Deb, 'Optimization for Engineering Design', Prentice Hall of India 4. G.V. Reklaites, A. Ravindran and K.M.Rogsdeth, 'Optimization' 5. N.S. Kambo, 'Mathematical Programming Techniques', Affiliated East-West Press 6. Els Golts, 'Differential Equations and Calculus of Variations', Mir Publications. 7. G. N. Vanderplaats, 'Numerical Optimization Techniques for Engineering Design With Applications', McGraw-Hill, 1984.

23MTCADL448 - Design of Experiments

Teaching Scheme				Credits	Evaluation Scheme						
					Theory				Practical		
L	T	P	Total Hours		TAE	CAE	ESE	Duration of ESE (Hrs.)	INT	EXT	Total Marks
3	-	-	3	3	20	30	50	3	-	-	100

Course Objectives	1.To use statistical concepts in experimentation and data dependent modeling 2. To understand the important role of design of experiments in new product design, manufacturing process development, and process improvement. 3. To analyze the results from planned investigations to obtain conclusions. 4.To use factorial experiments for understanding system behaviour
Course Outcomes	Upon successful completion of the course, students will be able to: 1. Plan, design, and conduct experimental investigations efficiently and effectively. 2. Understand and interpret, using statistical tools, experimental data and characteristic behavior. 3. Choose an appropriate experimental design strategy and analysis to evaluate and optimize new product design or processes.

Course content:

Unit	Contents	Hours
I	Introduction: Approaches to the study of the research problem and problem formulation, formulation of hypotheses, feasibility, preparation and presentation of proposal for a research investigation, basic principles of design of experiments, some typical applications of experimental design, guidelines for designing experiments, strategy of experimentation.	8
II	Introduction to Statistical Analysis: Probability and probability distributions; binomial, Poisson, exponential and normal distributions and their applications, primary and secondary data, their collection and validation, methods of sampling, regression and correlation analysis, linear regression models, estimate of parameters in linear regression models.	8
III	Analysis of Variance**:** Introduction, regression model diagnostics, hypothesis testing in multiple regression, confidence intervals in multiple regression, testing for lack of fit, tests of significance based on normal, t and chi-square distributions, the F-test, example of	8

	ANOVA process, degrees of freedom, error variance and pooling, error variance and application.	
IV	Simple Comparative Experiments**:** Randomized designs, complete block design, Latin square design, balanced incomplete block design, inferences about the differences in means, paired comparison designs, inferences about the variances of normal distributions, completely randomized and randomized block designs.	8
V	Introduction to Factorial Design **:** Basic definition and principles, advantages of factorials, general factorial design, two level and three level factorial designs, response surface methodology, fitting response curves and surfaces, blocking in a factorial design.	8

Text /Reference books	1. Douglas C Montgomery, 'Design and Analysis of Experiments', John Wiley & Sons, New York, 1996, 4th Edition 2. John P.W.M., 'Statistical Design and Analysis of Experiments', Macmillan, New York, 1971 3. Montgomery D.C., Runger G. C., 'Introduction to Linear Regression Analysis', Wiley New York, 1992, 2nd Edition 4. Myers R.H., Montgomery D. C., 'Response Surface Methodology: Process And Product Optimisation Using Designed Experiments', Wiley, New York, 1995 5. Taguchi, 'Introduction to Quality Engineering', Asian Productivity Organisation, G. UNIPUB, White Plains, New York. 6. Taguchi, 'System of Experimental Design: Engineering Methods to Optimize Quality and Minimize Cost', G. UNIPUB, White Plains, New York 7. C. R Kothari, 'Research Methodology', Wishwa Prakashan 8. J.W. Bames, 'Statistical Analysis for Engineers & Scientists', McGraw Hill, N.York 9. Phillip J. Ross, 'Taguchi Techniques for Quality Engineering', McGraw Hill, Intl. II Edition, 1995.

23MTCADL449 - Vibration Analysis and Condition Monitoring

Teaching Scheme				Credits	Evaluation Scheme						
					Theory				Practical		Total
L	T	P	Total Hours		TAE	CAE	ESE	Duration of ESE (Hrs.)	INT	EXT	
3	-	-	3	3	20	30	50	3	-	-	100

Course Objectives	1.To understand and appreciate the importance of vibrations in mechanical design of machine parts that operate in vibratory conditions 2.To be able to obtain linear vibratory models of dynamic systems with changing complexities (SDOF, MDOF) 3.To be able to make free and forced (harmonic, periodic, non-periodic) vibration analysis of single and multi-degree of freedom linear systems 4.To be able to monitor the dynamic performance and condition of rotating machines and diagnose faults through signal processing
Course Outcomes	Upon successful completion of the course, students will be able to: 1. Analyze mathematical models of vibratory systems to determine its response and apply these to real life engineering systems 2. Use numerical techniques and Lagrange's equations for linear and nonlinear vibratory systems and determine vibratory responses of SDOF and MDOF systems to harmonic, periodic and non-periodic excitation 3. Monitor dynamic performance and condition of rotating machines and diagnose faults through signal processing

Course content:

Unit	Contents	Hours
I	Free body diagram, free & forced vibration, undamped and damped single degree of freedom systems subjected to harmonic and other periodic excitations, impulse response, convolution integral and response to arbitrary excitation, vibration isolation and transmissibility, solution using Laplace transform, Runga-Kutta method, structure damping.	8
II	Energy method applied to multi degree freedom system, Lagrange's equation, generalized mass, formulation of mass, damping and stiffness matrix and its numerical solutions, vibration absorber, torsional vibration of two and three disc system, geared rotor system, influence coefficients and flexibility matrix of bending vibration of beam and multi-disc rotor, mode shapes and orthogonally principle	8
III	Numerical techniques for single and multiple degrees of freedom (SDOF, MDOF) systems, matrix iteration method, Holzer's method for torsional vibration, Dunkeley's method for critical speed determination of multi disc rolor, Rayleigh quotient sweeping matrix method for determination of all the natural frequencies and mode shapes, Raleigh-Ritz method, modal matrix and expansion theorem, free and forced response by modal analysis	8
IV	Vibration of continuous system, axial vibration of rod, bending vibration of beam and torsional vibration of shaft, Hamilton's principle and derivation of equation of motion, Rayleigh quotient, modal co-ordinates and modal forces, free and forced response through modal analysis	8
V	Machinery monitoring using vibration, transducers, spectrum analyzers, concept of signature & prediction of trouble by signature monitoring, trend analysis and approach for diagnostics.	8

Text /Reference books	1. W. T. Thomson, 'Theory of Vibration', CBS Publishers, Delhi, 2. L. Meirovitch, 'Elements of Vibration Analysis' 3. J. S. Rao & K. Gupta, 'Mechanical Vibrations' 4. J. S. Rao, 'Advanced Theory of Vibration' 5. Victor Wowk, 'Machinery Vibration: Measurement and Analysis', Mc-Graw Hill Publication. 6. Kolacoat," Vibration Based Condition Monitoring", Prentice Hall Publication. 7. J. S. Rao, 'Vibration Condition Monitoring of Machines' 8. Gandall & Mark, 'Random Vibrations'

23MTSHP602 - Advanced Communication Skills

Teaching Scheme				Credits	Continuous Evaluation Scheme					
					Theory			Practical		
L	T	P	Total Hours		TAE	CAE	ESE	INT	EXT	Total Marks
-	-	2	2	1	-	-	-	25	-	25

Course Objectives	1. To develop ability to communicate and express effectively and assertively 2. To enhance quality of learning and communication by using effective public speaking techniques. 3. To create awareness of advanced techniques of public speaking and one-to-one communication
Course Outcomes	Upon successfully undergoing the course, students will be able to: 1. Express ideas and views in an effective and assertive manner in society and as a professional 2. Analyze, evaluate and summarize conversations, texts, charts, graphs and make presentations more effectively 3. Apply knowledge of phonetics to articulate speech

Course content:

Contents
Instructions are imparted through class room teaching, case studies, demos, practical exercises and training at Language Laboratory to cover the following: 1. Speech process, message, speech style, & encoding. 2. Strategies for good conversation, fluency & self-expression with good vocabulary. 3. Listening skills, 4. Good pronunciation, voice quality, accent, intonation, & body language. 5. Group discussion & strategies. 6. Presentation skills & its importance, need for planning, organizing and improving through rehearsals, preparing an effective power point presentation 7. Professional writing skills, business letters, Salas letter, resume & job application. 8. Note taking, summarizing, paraphrasing and referencing skills. 9. Oral drills through extempore and debate. 10. Interpretation of non-verbal inputs such as graphs & charts.

M.Tech. 2nd Semester

23MTCADL547/23MTCADP547: Product Design and Development											
Teaching Scheme				Credits	Evaluation Scheme						
					Theory				Practical		
L	T	P	Total Hours		TAE	CAE	ESE	Duration of ESE (Hrs.)	INT	EXT	Total Marks
4	-	2	6	5	20	30	50	3	25	25	150

Course Objectives	1. To develop competence in using tools and methods for product design and development. 2. To create awareness of the role of multiple functions in creating a new product (e.g. marketing, finance, industrial design, engineering, production). 3. To develop ability to coordinate multiple, interdisciplinary tasks in order to achieve a common objective. 3. To be able to integrate specific knowledge from other fields of studies through practice.
Course Outcomes	Upon successful completion of the course, students will be able to: 1. Write programs that demonstrate geometrical transformations Explore the boundaries of design methodologies and decision making for real product design. 2. Use skills and knowledge gained to create new products. 3. Incorporate and select right approaches and considerations for successfully developing new product designs.

Course Contents:

Unit	Contents	Hours
I	Design fundamentals, importance of product design, type of design product definition product specification, phases of production development: conceptual, embodiment and detailed design, product and technology development cycle, concept generation and evaluation methods	8
II	Material selection, importance of classification of material, performance characteristics, selection criteria, Ashby material selection chart, economics, cost versus performance, process selection – importance types of manufacturing processes and their classification, sources of information selection criteria material and process selection methods, expert systems.	8
III	Benchmarking, DFM, DFA, DFX, fairly supplier involvement robust design, identification of customer needs, customer requirements, QFD concurrent engineering, embodiment design, product architecture, configuration design, parametric design, role of models in design, mathematical modeling, reliability theory, design for reliability, reliability centered maintenance, robust design-failure mode effect analysis.	9
IV	Methods of cost estimates, industrial engineering approach, parametric approach, introduction to assembly modeling, top-down & bottom-up approaches of AM, mating conditions representation schemes, generation of assembly sequence	8
V	Product development cycle and importance of prototyping, types of prototypes, principles and advantages, different types of generative manufacturing process viz stereo lithography, FDM, SLS etc, factors concerning to RP, consideration for adoptions, advantages, accuracy and economic consideration.	7

Text books/Reference books	1. Kevin Otto, Kristin Wood, 'Product Design', Pearson 2001 2. Dieter George E. 'Engineering Design', McGraw Hill Pub. Company , 2000 3. Ulirich Karl T. and Eppinger Steven D, 'Product Design and Development', McGraw Hill Pub Company, 1995. 4. Bralla, James G, 'Handbook of Product Design for Manufacturing', McGraw-Hill Pub. Company, 1986. 5. Martti Mantilya, 'An Introduction to Solid Modeling', Computer Science Press. 6. Chitale and Gupta, 'Product Design &Manufacturing', PHI publication, 3rd edition, 2005

List of Experiment

Sr. No.	Name of Experiment	Mapping With CO
1	Study of Product design, development and management process over whole product life cycle.	CO1
2	Methodology for product design, development and management.	CO1
3	Study of various creative process techniques in synthesizing information, problem-solving and critical thinking.	CO1
4	Employment of hand drawing and drafting principles to convey concepts.	CO2
5	Recognition of basic family of materials used in soft-goods and hard-goods, including sustainable materials and manufacturing processes.	CO2
6	Study of steps involved in Product performance test.	CO2
7	Build prototype models for hard-goods and soft-goods and packaging.	CO3
8	Case study	CO3

23MTCADL548/23MTCADP548: Finite Element Analysis

Teaching Scheme				Credits	Evaluation Scheme						
					Theory				Practical		
L	T	P	Total Hours		TAE	CAE	ESE	Duration of ESE (Hrs.)	INT	EXT	Total Marks
4	-	2	6	5	20	30	50	3	25	-	125

Course Objectives	1. To enable understanding of fundamental ideas of the FEM 2. To learn the theory and characteristics of finite elements that represent engineering structures. 3. To know the behavior and usage of each type of elements covered in this course 4. Be able to prepare a suitable FE model for structural mechanical analysis problems 5. One can interpret and evaluate the quality of the results (know the physics of the problems)
	Upon successful completion of the course, students will be able to: 1. Students will demonstrate an ability to derive element matrix equation by different methods by applying basic laws in mechanics and integration by parts

Course Outcomes	2. Students will demonstrate an ability to apply the steps required for FEM solution to variety of physical systems and obtain engineering design quantities 3. Identify the application and characteristics of FEA elements such as bars, beams, planar elements, and common 3-D elements. 4. Apply existing 3-D computer-aided design (CAD) skills to prepare models for finite element analysis.

Course Contents:

Unit	Contents	Hours
I	Objective of the course, basic steps in FEM formulation, general applicability of the method fundamental concept of FEM, scope of FEM in Engg, applications, principle of minimum potential energy, brief introduction to different numerical method, FEM and FDM, concept of virtual work, Raleigh – Ritz method	8
II	One dimensional finite element analysis, general form of total potential for 1-D, linear and quadratic shape function. finite element modeling and analysis using bar and beam element – stiffness matrix assembly, boundary conditions, load vector, applications to heat transfer in 1-D element.	10
III	Two dimensional finite element analysis, two dimensional problems using CST and LST – formulation of CST and LST elements, plane stress, plain strain and axisymmetric formulation, basic boundary value problem in 2 dimensions- triangular, quadrilateral, higher order element. Applications to heat transfer in 2-dimension	10
IV	Applications in heat transfer & fluid mechanics, one dimensional heat transfer element, application to one-dimensional heat transfer problems, scalar variable problems in 2-dimensions, applications to heat transfer in 2-dimension, application to problems in fluid mechanics in 2-D.	8
V	Dynamic analysis using finite element method, introduction, free vibration problems, equations of motion, longitudinal vibration of bars, transverse vibration of beams, introduction to transient field problem, direct integration methods.	8

Text books/Reference books	1. T.R. Chandrupatla & A. D. Belegundu , 'Introduction to Finite Elements in Engineering', PHI Publication, 3rd Edition, 2002 2. S.P. Timoshenko, 'Theory of Elasticity', Tata McGraw Hills 3. R.D. Cook, 'Concept and Applications of Finite element Analysis', John Willey & Sons 4. D.W. Griffiths, D.A. Nethercot, 'The Finite Element Method – A Basic Introduction for Engineers', Granada Publishing. 5. T.J.R. Hughes, 'The Finite Element Method: Linear Static and Dynamic Finite Element Analysis', Dover Publications, 2000. 6. R.W. Lewis, P. Nithiarasu and K.N. Seetharamu, 'Fundamentals of the Finite Element Method for Heat and Fluid Flow', Wiley, 2004.

List of Experiment

Sr. No.	Name of Experiment	Mapping With CO
1	Any two problems using bar element.	CO1,CO2,CO3
2	Any two problems using truss element.	CO1,CO2,CO3
3	Any two problems using CST element.	CO1,CO2,CO3

4	Any one problem using axis symmetric element.	CO1,CO2,CO3
5	Any one problem of free vibration analysis using bar element.	CO2,CO3, CO4
6	Any one problem of Torsion of Prismatic bars.	CO2,CO3, CO4
7	Any one problem on Steady State Heat conduction.	CO2,CO3, CO4

23MTCADL555: Advanced Machine Design

Teaching Scheme				Credits	Evaluation Scheme						
					Theory				Practical		
L	T	P	Total Hours		TAE	CAE	ESE	Duration of ESE (Hrs.)	INT	EXT	Total Marks
4	-	-	4	4	20	30	50	3	-	-	100

Course Objectives	1. To apply basic concepts and fundamentals of stress and strain for product design and analysis. 2. To be able to use differential equations of equilibrium and compatibility equations for stress analysis. 3. To learn various theories of failure & their significance in practical problem solving. 4. To apply strain energy concepts to find out the solution of statically indeterminate problems. 5. To understand and apply the concept of fluctuating load in component and system design.
Course Outcomes	After successfully completing the course students will able to: 1. Do stress analysis using differential equations of equilibrium and compatibility equations. 2. Apply various theories of failure to solve practical problems in machine designing. 3. Apply strain energy concepts to find out the solution of statically indeterminate problems. 4. Design machine components under fluctuating load conditions.

Course Contents:

Unit	Contents	Hours
I	Elasticity and Stress Strain Relations: Elasticity, fundamentals of stress and strain, Hooke's law, Poisson's ratio, elastic constants, plane stress & plane strain, principal stresses, Mohr's circle, principal stresses from Mohr's circle.	**8**
II	Differential Equations of Equilibrium: Differential equations of equilibrium in two-dimensional cartesian co-ordinates, boundary conditions, compatibility equations in Cartesian co-ordinates, stress function.	**8**
III	Theories of Failure: maximum normal stress theory, maximum shear stress theory, maximum normal strain theory, distortion- energy theory, Mohr's theory, significance of theories of failure, use of factor of safety in design, selection of materials for engineering applications.	**8**
IV	Energy Method: Elastic strain energy, Maxwell-Betti-Rayleigh reciprocal theorem, Castigliano's theorem, strain energy due to axial force, shear force, torsion, and bending moment.	**8**

V	Design against Fluctuating Load: Stress concentration, fluctuating stresses, fatigue failure, endurance limit, s-n curve, notch sensitivity, and reversed stresses-design for finite and infinite life, Soderberg and Goodman lines.	**8**

Text books/Reference books	1. L S Srinath, 'Advanced Solid Mechanics', Tata McGraw-Hill 2. S P Timoshenko, J N Goodier, 'Theory of Elasticity', McGraw- Hill, Third Edition 3. M.F. Spotts & T.E. Shoup, 'Design of Machine Elements', Pearson Education 4. Joseph E. Shigley & Chales R. Mischke, 'Mechanical Engineering Design', McGraw Hill 5. George B. Dieter, 'Engineering Design', McGraw Hill 6. Robert L. Norton, 'Machine Design - An Integrated Approach', Pearson Education 7. Arhur H. Burr & John B. Chetham, 'Mechanical Analysis & Design', Prentice Hall India 8. Robert C. Juvinall & Kurt M. Marshel, 'Fundamentals of Machine Component Design'.

23MTCADL549: Modeling & Simulation

Teaching Scheme				Credits	Evaluation Scheme						
					Theory				Practical		
L	T	P	Total Hours		TAE	CAE	ESE	Duration of ESE (Hrs.)	INT	EXT	Total Marks
3	-	-	3	3	20	30	50	3	-	-	100

Course Objectives	1. To understand simulation as a tool for providing solutions to various applications, characteristics of queuing systems and performance measures. 2. To understand the use of random numbers for simulating various real life situations and develop the mathematical models. 3. To enable learning about model building, verification and validation of simulation models of manufacturing systems, material handling system and introduce simulation languages and packages.
Course Outcomes	Upon successful completion of the course, students will be able to: 1. Students will be able to select appropriate simulation tool to develop the solution for the real life situations pertaining to manufacturing system, material handling systems. 2. Students shall be able to develop the mathematical models of the real life systems using random numbers and simulate the same to generate the solution. 3. The students shall be able to use statistical procedures for comparing real world observations and simulation output data.

Course Contents:

Unit	Contents	Hours
I	Introduction to simulation as a tool, areas of application, system model, components of system, system environment, types of system model, steps in a simulation study, discrete event system simulation, event scheduling, time advance mechanism, list processing - basic properties and operations, dynamic allocation, linked lines.	7

II	Characteristics of queuing systems, transient and steady-state behavior, long-run performance measures, infinite-population steady-state models, finite-population models	7
III	Properties and generation of random numbers, testing of generated random numbers, random variate generation: Exponential, Uniform, Weibull, Triangular, Empirical, Discrete distributions, direct transformation for normal distribution, convolution method, acceptance-rejection technique	8
IV	Data collection, identifying distributions, parameter estimation, goodness-of-fit tests, multivariate and time series input models, model building, verification, validation process, verification of simulation models, calibration and validation of models: validation of assumptions, input-output transformations, validation of input-output using historical data and turning test, modeling manufacturing systems, material handling system, goals and performance measures, modeling down times and failures, trace-driven models, case studies of manufacturing and material handling systems.	8
V	Statistical procedures for comparing real world observations and simulation output data, simulation languages, introduction to SIMLIB, SIMAN, SIMSCRIPT, SLAM-II, Promodel general desription action times, succession of events, choice of paths, simulation of mfg. shop, facilities & storages, gathering statistics, conditional transfers, program control statements, GPSS examples.	8

Text books/Reference books	1. J. Banks, 'Discrete-Event System Simulation', Prentice Hall (India) 2. S. Law, 'Simulation Modeling and Analysis', McGraw Hill Publishing Co. 3. N. Deo , 'Discrete Simulation using Digital Computers', 4. J. Gordon , 'System Simulation', Prentice Hall (India) 5. A.M.Law & W.D. Keltron, 'Simulation Modeling & Analysis', McGraw Hill International series. 6. Mikell P. Groover, 'Automation, Production Systems and Computer Integrated Manufacturing', PHI Learning Pvt. Ltd., 2010

23MTCADL550: Computational Methods for Design

Teaching Scheme				Credits	Evaluation Scheme						
					Theory				Practical		
L	T	P	Total Hours		TAE	CAE	ESE	Duration of ESE (Hrs.)	INT	EXT	Total Marks
3	-	-	3	3	20	30	50	3	-	-	100

Course Objectives	1. To understand different finite element methods, governing equations and boundary conditions and finite difference equations. 2. To use mathematical and computational techniques to solve fluid flow problems under different boundary conditions.
Course Outcomes	Upon successful completion of the course, students will be able to: 1. Formulate solutions to problems using different finite element methods, governing equations and boundary conditions and finite difference equations. 2. Apply mathematical and computational techniques to solve fluid flow problems under different boundary conditions

Course Contents:

Unit	Contents	Hours

I	Introduction: Finite difference method, finite volume method, finite element method, governing equations and boundary conditions, Derivation of finite difference equations, Solution methods: Solution methods of elliptical equations finite difference formulations, interactive solution methods, direct method with Gaussian elimination.	**7**
II	Parabolic Equations: Explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct method with tri-diagonal matrix algorithm. Hyperbolic equations: explict schemes and Von Neumann stability analysis, implicit schemes, multi-step methods, nonlinear problems, second order one-dimensional wave equations.	**7**
III	Burgers Equations: Explicit and implicit schemes, Runge-Kutta method. Formulations of incompressible viscous flows: Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, vortex methods.	**8**
IV	Treatment of Compressible Flows: Potential equation, Eluer equations, Navier - stokes system of equations, flow field - dependent variation methods, boundary conditions, example problems.	**8**
V	Finite Volume Method: Finite volume method via finite difference method, formulations for two and three-dimensional problems. Standard variational methods - 1: Linear fluid flow problems, steady state problems, Standard variation methods – 2: Transient problems.	**8**

Text books/Reference books	1. T. J.Chung, 'Computational Fluid Dynamics', Cambridge University press, 2002. 2. Frank Chorlton, 'Text Book of Fluid Dynamics', CBS Publishers & Distributors, 1985. 3. S. V. Patankar, 'Numerical Heat Transfer and Fluid Flow', McGraw-Hill 4. H. K. Versteeg & W. Malalasekera, 'An Introduction to Computational Fluid Dynamics', Longman Scientific & Technical. 5. John D. Anderson Jr, 'Computational Fluid Dynamics', McGraw Hill Book Company.

23MTCADL551: Computer Aided Tool Design

Teaching Scheme				Credits	Evaluation Scheme						
					Theory				Practical		
L	T	P	Total Hours		TAE	CAE	ESE	Duration of ESE (Hrs.)	INT	EXT	Total Marks
3	-	-	3	3	20	30	50	3	-	-	100

Course Objectives	1. To understand the need of using computers for designing cutting tools and dies. 2. To learn about different types of production presses, dies, jig and fixtures and designing inspection gauges 3. To understand basics of metal cutting and tool geometry and design single and multi-point cutting tools such as drills, milling cutters, broaches etc. 4. To select appropriate cutting tools for NC, CNC machines 5. To learn different forging processes, dies, equipment and their selection and design
Course Outcomes	Upon successful completion of the course, students will be able to: 1. Use computers for designing different types of cutting tools, metal forming and forging dies, jigs and fixtures. 2. Design limit gauges for inspection. 3. Select single and multipoint metal cutting tools geometry for different machining

	applications for NC, CNC machines

Course Contents:

Unit	Contents	Hours
I	Three dimensional stress pattern, true stress and true strain, principal stresses, yield criteria, Vos Mises criterion, Tresca's criterion, Von Mises Yield for plane strain problems, Coloumb function and sticking friction.	**8**
II	Press working, types of presses, types of dies, computer aided design of cutting dies like simple die, compound die, progressive die and combination die, forming dies like bending die, drawing die, flanging die, coining die, embossing die.	**8**
III	Jigs and fixtures, principles of location and clamping, unconventional clamping systems, design of various types of jigs for various parts, design of different types of fixtures, Taylor's principles of gauge design, and design of limit gauges.	**8**
IV	Forging in plane strain, forging of circular disc, effect of friction, forging equipment, defects in forged products, causes & remedies, design of forging dies.	**8**
V	Mechanics of metal cutting, design of single point tools, design of multipoint cutting tools like drills, reamers, broaches, taps and milling cutters, design of tools for joining processes, design of tools for NC, CNC machines.	**8**

Text books/Reference books	1. C. Donaldson, G. LeCain, V. Goolld, and J. Ghosh, 'Tool Design', McGraw Education (India), New Delhi, 2012, Fourth Edition 2. F. Wilson (Chief Editor ASTME), 'Fundamentals of Tool design', Prentice Hall of India Pvt. Ltd., New Delhi, 1976 3. Pollock, 'Fundamentals of Tool Design' Prentice Hall; 2 Sub edition (February 1988) 4. Grant, 'Unconventional Clamping Systems' Kempster, 'Fundamentals of Tool Design"

23MTCADL553: Manufacturing System Integration and Management

Teaching Scheme				Credits	Evaluation Scheme						
					Theory				Practical		
L	T	P	Total Hours		TAE	CAE	ESE	Duration of ESE (Hrs.)	INT	EXT	Total Marks
3	-	-	3	3	20	30	50	3	-	-	100

Course Objectives	1. To study application of computers and integration of operations in manufacturing systems**.** 2. To understand capacity planning and inventory management and understand materials requirement planning**.** 3. To understand ERP and MRPII as modern production control tools**.** 4. To understand and apply JIT, pull manufacturing and various techniques for waste reduction in manufacturing by taking open minded decisions based objectivity and rational analysis. 5. To study shop floor control techniques.
Course Outcomes	Upon successful completion of the course, students will be able to: 1. Develop master production schedule and plan production activities on short and long

	term basis. 2. Use JIT, MRP, ERP, MRP-II systems and various productivity improvement concepts in manufacturing. 3. Design, develop and implement computer based inventory control systems and reduce different wastes in production. 4. Plan, organize, schedule and implement shop floor manufacturing activities and control them

Course Contents:

Unit	Contents	Hours
I	Manufacturing planning and control, computer integrated production management systems, business plan, master production schedule, aggregate production planning, rough cut capacity planning, materials requirement planning (MRP), operations planning & strategies, capacity planning and utilization, dependent and independent demand, BOM, manufacturing and design data base, factory data collection systems.	**8**
II	Functions of inventory management, inventory systems, inventory control models, advanced inventory models, purchasing, demand management, master production scheduling functions, MRP logic, planning factors, inputs-outputs of MRP, recourses planning, manufacturing resources planning (MRPII), framework of MRP II system, close the loop approach, benefits and prospects for MRPII, enterprise resource planning (ERP), supply chain inventory management.	**8**
III	Production planning and scheduling under different circumstances, shop floor control functions, order release, order scheduling, loading, production leveling, sequencing rules, order progress, final assembly scheduling, factory coordination, production activity control, optimized production technology, input output control, production reporting, supplier scheduling.	**8**
IV	Limitations of traditional manufacturing systems, responding to changing manufacturing environment, repetitive manufacture, group technology and flexible manufacturing systems, concurrent engineering, value added focus, small lot production, setup time reduction, push and pull production control systems, execution and control in pull environments, achieving pull production, sources of waste, JIT manufacturing principles and operating conditions, supply chain coordination.	**8**
V	Japanese contributions to world class manufacturing, lean manufacturing, Toyoto production systems, workers involvement, quality circles, continuous improvement techniques, visual management and 5-S, Kanban system, autonomation, error prevention, total productive maintenance, agile manufacturing, six sigma concept.	**8**

Text books/Reference books	1. Jonsson P. & Mattson S. A., 'Manufacturing Planning and Control', Tata McGraw Hill Education Private Limited, 2011 2. Vollman T.E., Berry W.L., Whybark D.C. & Jacobs F.R., 'Manufacturing Planning and Control for Supply Chain Management', Tata McGraw Hill Education Private Limited, 2011 3. Adam E.E. & Ebert R.J., 'Production & Operations Management', Prentice Hall of India Private Limited, 5th Edition, 2005 4. Grover M. P., 'Automation, Production Systems & Computer Integrated Manufacturing', PHI Learning Private Ltd, 3rd Edition, 2010 5. Gopalkrishnan N., 'Simplified Lean Manufacture', PHI Learning Private Ltd, 2010 6. Bubidge J. L., 'Group Technology in Engineering Industry', Mechanical

	Engineering Pub, London , 1979. 7. Askin R. G. and Vakharia, A. J., 'G. T. Planning and Operation in the Automated Factory, Cleveland, D. I. 8. Irani, S. A., 'Cellular Manufacturing Systems Hand Book' 9. Kamrani. A. K., Pasaei, H. R. & Liles, D. H. (Editors), 'Planning Design and Analysis of Cellular Manufacturing Systems', Elsevier, 1995. 10. Nicholes Jonn M., 'Competitive Management' McGraw Hill International Editions. 11. Khalid Shaikh, 'Manufacturing Resource Planning', Tata McGraw Hill Co. Ltd. 12. James M. Moore, 'Plant Layout and Design', McMillan Company.

23MTCADL552: Plastics and Composites

Teaching Scheme				Credits	Evaluation Scheme						
					Theory				Practical		
L	T	P	Total Hours		TAE	CAE	ESE	Duration of ESE (Hrs.)	INT	EXT	Total Marks
3	-	-	3	3	20	30	50	3	-	-	100

Course Objectives	1. To study basics about the different kinds of polymeric materials predominantly being used for various engineering applications. 2. To study different manufacturing techniques of polymeric materials and fabrication techniques of the polymeric materials. 3. To learn about basics of the different categories of the composite materials including powder metallurgy techniques. 4. To study the different manufacturing techniques of the composite materials.
Course Outcomes	Upon successful completion of the course, students will be able to: 1. Choose the right type of plastic materials and ceramics for engineering applications. 2. Select different plastic processes for designing and manufacturing needs of intended product. 3. Design and develop fiber based materials and plastic products and use processes for their shaping, joining and coating. 4. Understand various methods of composite manufacturing and their applications.

Course Contents:

Unit	Contents	Hours
I	Introduction to nonmetallic materials, introduction to polymers, classification of polymers, and overview of important polymer processes - extrusion, injection moulding, blow molding, thermoforming, compression moulding, Introduction to the functional process analysis of polymer extrusion.	**8**
II	Polymer blending, master batches of polymers, properties of polymers important for basic polymer process analysis, characterization of polymers important for basic polymer process analysis.	**8**
III	Joining of plastics, heated tool welding, ultrasonic welding, vibration welding, spin welding, hot gas welding, extrusion welding, laser welding, IR welding, resistative implant welding, induction welding, heat sealing, flash free welding, friction stir welding.	**8**
IV	Fibers, matrix materials, interfaces, polymer matrix composites, metal matrix composites, ceramic matrix composites, whiskers, carbon fiber composites.	**8**

V	Different composite processing methods, industrial sector wise engineering applications of composite materials, composite in aircraft industry, composite for structural application, composites as biomaterials, miscellaneous applications.	**8**

Text books/Reference books	1. J. R. Fried, 'Polymer Science and Technology', Prentice Hall of India Pvt. Ltd., New Delhi, Eastern Economy Edition, 2000. 2. V. R. Gowrarikar, M. V. Viswanathan & J. Sridhar, 'Polymer Science', Wiley Eastern Ltd., 1988. 3. P. Ghosh, 'Polymer Science and Technology', Tata McGraw-Hill Publishing Company, New Delhi, 2002. 4. R. Sinha, 'Outlines of Polymer Technology: Manufacture of Polymers', Prentice Hall of India Pvt. Ltd., New Delhi, 2000. 5. F.L. Matthews and R.D.Rawlings, 'Composite Materials: Engineering and Science', Chapman & Hall, London 1994. 6. Bryan Harris, 'Engineering Composite Materials', IOM Communications Ltd., 1999. 7. S. C. Sharma, 'Composite Materials', Narosa, 2000.

23MTCADL556: Design of Piping System

Teaching Scheme				Credits	Evaluation Scheme						
					Theory				Practical		
L	T	P	Total Hours		TAE	CAE	ESE	Duration of ESE (Hrs.)	INT	EXT	Total Marks
3	-	-	3	3	20	30	50	3	-	-	100

Course Objectives	1. To understand the physical phenomena which affect the design of piping systems for various industries 2. To be able to use standard software, codes, data and methods to design process equipment and piping layout and draw appropriate specifications for the selected components and systems. 3. To be able to provide adequate safety measures during fabrication / installation of piping systems and undertake inspection and testing.
Course Outcomes	After successfully completing the course students will able to: 1. Understand the physical phenomena which affect the design of piping systems for various industry sectors. 2. Use standard software, codes, data and methods to design and select process equipment and piping layout and draw appropriate specifications. 3. Ensure provision of adequate safety measures during fabrication / installation of piping systems and undertake inspection and testing.

Course Contents:

Unit	Contents	Hours

I	Introduction to piping engineering and role of piping engineer in various fields, industry functioning and plant overview, function of process equipment and their piping requirement, study and applications of plant design management system (PDMS) software.	**8**
II	Fundaments of fluid flow through pipes, basic process requirement of plant/project detailed study of various piping systems, procedure of designing piping system, material selection for various process services, piping elements, their joining methods, relevant standards / codes, their importance and applications, valves & nozzles.	**8**
III	Use of vendor data in design, various documents required for plant design, basic information on welding, it's testing and inspection preparation of piping material specification, valve specification and data sheets, nozzle orientation of process equipment, bill of material at various stages, isometric drawings and final MTO.	**8**
IV	Piping layout, line pressure drop, piping analysis, stress analysis of curved pipelines, development of equipment layout, piping layout, industrial plot plan.	**8**
V	Study and analysis of system using CAESAR II software, pipe supports & loop calculations, pipeline operation and maintenance-friction reduction, cleaning, coating, wear, leak detection, water hammer	**8**

Text books/Reference books	1. Peter Smith, 'Fundamentals of Piping Design', Gulf Publishing House, 2006 2. M. W. Kellogg Company, 'Design of Pipeline Systems', Martino Fine Books, 2009 3. G. K. Sahu, 'Handbook of Piping Design', New Age International, 1998 4. Mohinder L. Nayyar, **'**Piping Handbook', McGraw-Hill Education: New York, 2000, Seventh Edition 5. Rutger Botermans and Peter Smith,

23MTCADL557: Design of Material Handling System

Teaching Scheme				**Credits**	**Evaluation Scheme**						
					Theory				**Practical**		**Total**
L	**T**	**P**	**Total Hours**		**TAE**	**CAE**	**ESE**	**Duration of ESE (Hrs.)**	**INT**	**EXT**	
3	-	-	3	3	20	30	50	3	-	-	100

Course Objectives	1. A basic understanding of material handling equipment and facilities and the fundamental principles of material handling. 2. Ability to design and select material handling equipment, attachments, drives and systems and also understand their limitations. 3. An understanding of safety issues and regulations in material handling.
Course Outcomes	Upon successful completion of the course, students will be able to: 1. Select appropriate equipment for material handling and understand the applications as well as limitations of the different equipment. 2. Apply appropriate techniques for improving existing material handling systems. 3. Recognize the importance of safety issues in material handling.

Course Contents:

Unit	**Contents**	**Hours**

I	Types of interplant transporting facility, principal groups of material handling equipment, choice of material handling equipment, hoisting equipment, screw type, hydraulic and pneumatic conveyors, general characteristics of hoisting machines, surface and overhead equipment, general characteristics of surface and overhead equipment's and their applications.	**8**
II	Flexible hoisting appliances like ropes and chains, welded load chains, roller chains, selection of chains hemp rope and steel wire rope, selection of ropes, fastening of chains and ropes, different types of load suspension appliances, fixed and movable pulleys, different types of pulley systems, multiple pulley systems, chain and rope sheaves and sprockets.	**8**
III	Load handling attachments, standard forged hook, hook weights, hook bearings, cross piece and casing of hook, crane grab for Unit and piece loads, carrier beams and clamps, load platforms and side dump buckets, electric lifting magnets, grabbing attachments for loose materials, crane attachments for handling liquid materials.	**8**
IV	Arresting gear, ratchet type arresting gear, roller ratchet, shoe brakes and its different types like electromagnetic, double shoe type, thruster operated, controller brakes, shoe brakes, thermal calculations of shoe brakes and life of linings, safety handles, load operated constant force and variable force brakes general theory of band brakes, its types and construction.	**8**
V	Different drives of hosting gears like individual and common motor drive for several mechanisms, traveling gear, traveling mechanisms for moving trolleys and cranes on runway rails, mechanisms for trackless, rubber-tyred and crawler cranes, motor propelled trolley hoists and trolleys, rails and traveling wheels, slewing, jib and luffing gears, operation of hoisting gear during transient motion, selecting the motor rating and determining braking torque for hoisting mechanisms, drive efficiency calculations, selecting the motor rating and determining braking torque for traveling mechanisms, slewing mechanisms, jib and luffing mechanisms.	**8**

Text books/Reference books	1. N. Rudenko, 'Materials Handling Equipment', Envee Publishers, New Delhi, 2nd Edition, 1969 2. M. P. Alexandrov, 'Materials Handling Equipment', Mir Publications, Moscow, 1st Edition, 1981 3. Ronald G.A. and Charles R.S., 'Modeling and Analysis of Manufacturing System', New York, Wiley, 1993 4. McCormik E.J. and Sanders M., 'Human Factors in Engineering and Design', New York, McGraw-Hill, 1992 5. Sims R.E., 'Material Handling Systems, In Handbook of Industrial Engineering', 2nd edn, New York: John Wiley & Sons, 1992 6. Francis R.L., McGinnis L. and White J.A., 'Facility Layout and Location: An analytical Approach', Englewood Cliffs, NJ, Prentice-Hall, 1992 7. Muther R. and Wheeler J.D., 'Simplified Systematic Layout Planning', Kansas City, MO, Management and Industrial Publication, 1994 8. Ridley J., 'Safety at Work', Butterworth Heinemann Ltd., 1994 9. Alberto Garcia-diaz, J. Macgregor Smith, 'Facilities Planning and Design', Prentice Hall, 2007 10. Edward Frazelle, 'World-class Warehousing and Material Handling', McGraw Hill, 2004 11. Matthew P. Stephens, Fred E. Meyers, 'Manufacturing Facilities Design and Material Handling', Prentice Hall, 2009

23MTCADL554: Fracture Mechanics and Fatigue

Teaching Scheme				Credits	Evaluation Scheme						
					Theory				Practical		
L	T	P	Total Hours		TAE	CAE	ESE	Duration of ESE (Hrs.)	INT	EXT	Total Marks
3	-	-	3	3	20	30	50	3	-	-	100

Course Objectives	1. To understand failure mechanisms in materials and use the knowledge as a basis for predicting fracture and fatigue behavior. 2. To understand the mechanical behavior of materials, analyze and assess the strength using knowledge of material properties, sensors and data acquisition techniques and identify the material properties required in different situations. 3. To be able to predict fatigue life using S/N and fracture mechanics based computational methods. 4. To be able to identify the cause of failure of a material based on fracture surface observations.
Course Outcomes	Upon successful completion of the course, students will be able to: 1. Apply fracture mechanics to predict material failure. 2. Identify and describe the basic fracture and fatigue mechanisms. 3. Predict fatigue life using S/N and fracture mechanics based computational methods. 4. Identify the cause of failure of a material based on fracture surface observations.

Course Contents:

Unit	Contents	Hours
I	Transducers and Data Acquisition**:** Strain gage fundamentals, resistance wire and etched resistance foil gages, gage resistance and excitation voltage, gage material, strain gage arrangements, Mohr's circle strain analysis, strain gage bridge calibration, introduction to brittle coating, photostress coating, optical strain measuring techniques, introduction to thermocouple, thermistors, electrical resistance thermometers and resistance-temperature detectors for temperature measurement. signal conditioning, need for analog-to-digital (A–D) and digital-to-analog (D–A) converters, sampling frequency, aliasing error, frequency domain analysis, statistical decision making, experimental data verification.	**8**
II	Introduction to Failure Mechanisms**:** Elastic instability, plastic instability, yielding and plastic collapse, stationary creep, fracture and Mohr's failure criterion, resonance, linear-elastic fracture mechanics, modes of deformation, stress intensity factors, design and failure analysis using stress intensity concepts, stresses, stress concentration, stresses at crack tip, stress intensity factor, and fracture criteria, nondestructive evaluation.	**8**
III	Fatigue Analysis and Design of Structural Component**:** An introduction to fatigue, stress vs. life (s-n) curves, life prediction using the Palmgren-Miner rule, strain vs. life (e-N) curves, low-cycle fatigue(LCF), high-cycle fatigue (HCF), analysis of fatigue data and design s–n curves in the finite life region, factor for reliability, structural component is subject to cyclic uniaxial and combined loading, stress and strain -based fatigue analysis and design, crack propagation under cyclic loading.	**8**
IV	Computational Fracture Mechanics**:** Overview of numerical methods, traditional methods in computational fracture mechanics, the energy domain integral mesh design, linear elastic convergence, study analysis of growing cracks.	**8**
V	Environmentally Assisted Cracking in Metals**:** Corrosion principles, environmental cracking overview, stress corrosion cracking, hydrogen embrittlement, corrosion fatigue.	**8**

Text books/Reference books	1. T.L. Anderson, 'Fracture Mechanics: Fundamental and Applications', 3rd Edition, 2005, CRC Press. 2. Z.P. Bazant, J. Planas, 'Fracture and Size Effect in Concrete and Other Quasibrittle Materials', 1998. 3. F. Bower, 'Applied Mechanics of Solids', CRC Press, 2009. 4. M. Meyers, K. Chawla, 'Mechanical Behavior of Materials', Cambridge, 2009. 5. D. Broek, 'Elementary Engineering Fracture Mechanics', Springer; 4th edition (June 30, 1982) 6.Ashok Saxena, 'Non-Linear Fracture Mechanics for Engineers', 2nd edition

23MTCADP403: Research Methodology

Teaching Scheme				Credits	Evaluation Scheme					
					Theory			Practical		
L	T	P	Total Hours		TAE	CAE	ESE	INT	EXT	Total Marks
-	-	2	2	1	-	-	-	25	-	25

Course Objectives	1. To enable researchers to understand and appreciate the nature, complexities and challenges of research. 2. To equip them with knowledge and skills that will enable them to exercise choice between available techniques or methods of research. 3. To develop abilities to write technical reports, file patent applications and communicate findings in written and oral form.
Course Outcomes	After successfully completing the course students will able to: 1. Conduct a research activity independently or as a team member in a chosen narrow area of specialization. 2. Develop abilities to analyze complex engineering problem in scientific manner, find workable solutions, and communicate and present research findings in oral and written form. 3. Develop an attitude for continuous and lifelong learning.

Course Contents:

As per Direction No.10 of 2011 and Direction No.29 of 2012 of RTMNU, the course work is compulsory. The course covers different aspects of research methodology and quantitative methods of computer application as needed for undertaking research investigations. It provides for skills needed to review published work in the relevant field, effective delivery of seminars, developing the attitude for continuous and lifelong learning. It helps in developing clarity of thought and expression, communication and presentation skills, analytical abilities, critical appreciation of the existing literature and apply experimental or design skills.

The following principal areas are covered:

1. Introduction to research
2. Methods of research
3. Literature review

4. Tools and techniques of data collection
5. Sampling & hypothesis testing
6. Statistical techniques - linear and multiple regression
7. Data dependent modeling and analysis
8. Optimization techniques-Genetic Algorithm
9. Presentation of research findings
10. Report writing
11. Soft computing-ANN, Fuzzy, PSO
12. How to write a technical paper?
13.Patent & innovation
14. Scientific networking & evaluation of research
15. Do's and don'ts in publishing
16. Case presentations & lab visits for R&D facilities
17. Quantitative methods of computer applications
18. Application of modeling & simulations software (AUTOCAD, MATLAB & Simulink, LABVIEW)

THIRD SEMESTER

23MTCADP632: Industry Project Dissertation / Research (Phase-I)										
Teaching Scheme				**Credits**	**Evaluation Scheme**					
					Theory			**Practical**		
L	**T**	**P**	**Total Hours**		**TAE**	**CAE**	**ESE**	**INT**	**EXT**	**Total Marks**
-	-	24	24	12	-	-	-	200	-	200

Course Objectives	1. To develop the ability to analyze and use scientific approach in solving complex engineering problems. 2. To develop oral and written communication and presentation skills, critical review of the existing literature. 3. To develop design skills and the ability to conduct planned experimentation. 4. To develop an attitude of continuous and lifelong learning
Course Outcomes	Upon successful completion of research phase –I of dissertation, students shall be able to: 1. Analyze complex engineering problems, develop action plan and apply appropriate research methodologies to find workable solution. 2. Develop oral and written communication and presentation skills, critical review of the existing literature, experimental and design skills 3. Develop an attitude of continuous and lifelong learning

Course Contents:

The dissertation work is aimed at training the students to independently analyze and solve a complex engineering problem posed to them. The project may be a purely analytical piece of work, a completely experimental one or combination of both. The project may also be based on live industry problems and, in few cases, can also involve a sophisticated design work.

The project report is expected to show clarity of thought and expression, analytical skills, critical appreciation of the existing literature, experimental or design skills and develop the abilities for continuous and lifelong learning, leadership and team work and execution of assignments.

Each student shall select a problem in the field of specialization for dissertation work. The project topic shall be from the domain areas of simulation / fabrication / industrial problem solving / design. A student in consultation with his supervisor shall initiate action towards the end of second semester to identify research area and prepare synopsis after literature survey. Candidates are expected to commence project activities immediately after the completion of the second semester under the guidance of the Institute supervisor. There could be a co-supervisor if the project is interdisciplinary in nature. For an industry based project, the co-supervisor may be from the concerned industry.

Each student shall have to deliver a seminar on part of the dissertation work completed during the semester and shall include problem identification methodology, literature survey, scope of proposed work, research methodology to be adopted, status of fabrication (if any), plan of action etc.

FOURTH SEMESTER

23MTCADP633 : Industry Project Dissertation / Research (Phase-II)										
Teaching Scheme				**Credits**	**Evaluation Scheme**					
					Theory			**Practical**		
L	**T**	**P**	**Total Hours**		**TAE**	**CAE**	**ESE**	**INT**	**EXT**	**Total Marks**
-	-	48	48	24	-	-	-	150	150	300

Course Objectives	1. To develop the ability and skill sets to analyze and solve complex engineering problems, independently or as a team member, using modern tools and computational techniques. 2. To develop oral and written communication and presentation skills, critical review of the existing literature, experimental and design skills 3. To develop an attitude of continuous and lifelong learning
Course Outcomes	Upon successful completion of the dissertation, students will be able to: 1. Analyze and solve a complex engineering problem posed for investigative study, independently or as a team member, using modern tools and computational techniques. 2. Develop oral and written communication and presentation skills, critical review of the existing literature, experimental and design skills and showcase research findings through publications. 3. Develop an attitude of continuous and lifelong learning

Course Contents:

The student shall present his / her work before a board of experts and deliver a pre thesis submission seminar on the dissertation work completed by him / her under the guidance of the supervisor(s) during the third and the fourth semesters. The presentation shall include problem identification methodology, literature survey and gap analysis, research methodology adopted, fabrication (if any), experimentation details, observations, findings and outcome of the work, contribution to the field of knowledge etc.

The dissertation work should demonstrate that the student has developed to a satisfactory level the ability to independently analyze and solve a complex engineering problem posed to him / her as also developing abilities for continuous and lifelong learning, leadership and team work and execution of assignments. The project report is expected to show clarity of thought and expression, communication and presentation skills, analytical abilities, critical appreciation of the existing literature, experimental or design skills.

The student shall be allowed to submit the dissertation only after passing in all of the prescribed courses of the program, within the prescribed period, and after satisfactory performance in pre submission seminar.