NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

DEPARTMENT OF MECHANICAL ENGINEERING

SCHEME OF INSTRUCTION AND SYLLABI

FOR M.TECH. PROGRAM IN

COMPUTER INTEGRATED MANUFACTURING

Effective from 2014-15

NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

VISION

Towards a Global Knowledge Hub, striving continuously in pursuit of excellence in Education, Research, Entrepreneurship and Technological services to the society

MISSION

- Imparting total quality education to develop innovative, entrepreneurial and ethical future professionals fit for globally competitive environment.
- Allowing stake holders to share our reservoir of experience in education and knowledge for mutual enrichment in the field of technical education.
- Fostering product oriented research for establishing a self-sustaining and wealth creating centre to serve the societal needs.

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

To be a global knowledge hub in mechanical engineering education, research, entrepreneurship and industry outreach services.

MISSION

- Impart quality education and training to nurture globally competitive mechanical engineers.
- Provide vital state-of-the-art research facilities to create, interpret, apply and disseminate knowledge.
- Develop linkages with world class educational institutions and R&D organizations for excellence in teaching, research and consultancy services.

GRADUATE ATTRIBUTES

The Graduate Attributes are the knowledge skills and attitudes, which the students have at the time of graduation. These attributes are generic and are common to all engineering programs. These Graduate Attributes are identified by National Board of Accreditation.

1. **Scholarship of Knowledge**: Acquire in-depth knowledge of various manufacturing processes on a wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.
2. **Critical Thinking**: Analyze complex engineering problems critically, apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.
3. **Problem Solving**: Think laterally and originally, conceptualize and solve manufacturing engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, societal and environmental factors in the core areas of expertise.
4. **Research Skill**: Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.
5. **Usage of modern tools**: Create, select, learn 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.
6. **Collaborative and Multidisciplinary work**: Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.
7. **Project Management and Finance**: Demonstrate knowledge and understanding of engineering and management principles and apply the same to one’s own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economic and financial factors.
8. **Communication**: Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to

comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

9. **Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.
10. **Ethical Practices and Social Responsibility**: Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.
11. **Independent and Reflective Learning**: Observe and examine critically the outcomes of one's actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback.

CURRICULAR COMPONENTS FOR ALL M. TECH. PROGRAMS IN MECHANICAL ENGINEERING

Category	**Sem – I**	**Sem – II**	**Sem – III**	**Sem – IV**	**Total No. of credits to be earned**
Core courses	16	12	--	--	**28**
Electives	06	09	--	--	**15**
Lab Courses	04	04	--	--	**08**
Comprehensive Viva-Voce	--	--	04	--	**04**
Seminar	--	02	--	--	**02**
Dissertation	--	--	08	18	**26**
Total	**26**	**27**	**12**	**18**	**83**

DEPARTMENT OF MECHANICAL ENGINEERING

M. TECH. IN COMPUTER INTEGRATED MANUFACTURING

PROGRAM EDUCATIONAL OBJECTIVES:

Program Educational Objectives (PEOs) are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve. They must be consistent with the mission of the institution and Department. Department faculty members must continuously work with stakeholders (local employers, industry and RD advisors, and the alumni) to review the PEOs and update them periodically. The number of PEOs should be manageable and small in number, say 4±1, and should be achievable by the program.

PEO1	Design and develop Computer Integrated Manufacturing systems using the knowledg of mathematics, science, engineering and IT tools.
PEO2	Apply modern computational, analytical, simulation tools and techniques to face th challenges in manufacturing.
PEO3	Communicate ideas effectively with diversified groups to become lead professionals i academia and industry in advanced areas of manufacturing.
PEO4	Engage in continuous and life-long learning by exhibiting professionalism, ethica attitude and team work.

MAPPING OF MISSION STATEMENTS WITH PROGRAM EDUCATIONAL OBJECTIVES:

Mission Statement	**PEO1**	**PEO2**	**PEO3**	**PE04**
Impart quality education and training to nurture globally competitive mechanical engineers.	3	3	3	2
Provide vital state of the art research facilities to create, interpret, apply and disseminate knowledge.	3	2	3	3
Develop linkages with world class educational institutions and R&D organizations for excellence in teaching, research and consultancy services.	3	2	3	1

1: Slightly 2: Moderately 3: Substantially

MAPPING OF PROGRAM EDUCATIONAL OBJECTIVES WITH GRADUATE ATTRIBUTES:

PEO	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11
PEO1	3	3	3	3	3	3	-	-	-	-	1
PEO2	3	3	3	3	2	3	2	3	-	3	2
PEO3	2	1	2	2	1	3	3	3	-	2	2
PEO4	1	1	3	2	1	3	2	-	3	3	3

PROGRAM OUTCOMES:

Program Outcomes, as per NBA, are narrower statements that describe what the students are expected to know and be able to do upon the graduation. These relate to the knowledge, skills and behaviour the students acquire through the program. The Program Outcomes (PO) are specific to the program and should be consistent with the Graduate Attributes and facilitate the attainment of PEOs.

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

PO1	Apply knowledge of manufacturing engineering and management principles to design and evaluate automated manufacturing systems.
PO2	Analyze problems of manufacturing and industrial systems to formulate the design requirements for CIM systems.
PO3	Design, implement, and evaluate advanced manufacturing systems and processes, with appropriate consideration for public health and safety, cultural, societal and environmental considerations.
PO4	Design, conduct and analyze experiments using domain knowledge and concepts of design of experiments to arrive at valid conclusions.
PO5	Use state of the art IT tools and techniques for design and operation of advanced manufacturing systems.
PO6	Develop sustainable and eco-friendly manufacturing systems using the knowledge of contemporary issues.
PO7	Apply professional, ethical, legal, security and social issues in the design of manufacturing systems.
PO8	Function effectively, individually and in teams, on diverse and multidisciplinary environments to accomplish common goals
PO9	Communicate effectively with diversified groups to motivate and exhibit leadership qualities in the management of an enterprise.
PO10	Apply the principles of project management for effective execution of manufacturing projects.
PO11	Pursue life-long learning as a means of enhancing the knowledge and skills.

MAPPING OF PROGRAM OUTCOMES WITH PROGRAM EDUCATIONAL OBJECTIVES:

PEO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
1	3	3	3	2	2	1	1	1	2	2	2
2	3	3	3	3	3	1	1	1	1	2	2
3	2	2	2	2	3	2	2	3	3	1	1
4	1	1	1	1	1	2	3	3	3	2	2

1: Slightly 2: Moderately 3: Substantially

SCHEME OF INSTRUCTION

M. TECH. (COMPUTER INTEGRATED MANUFACTURING) COURSE STRUCTURE

I – Year, I – Semester

S. No.	Course Co	Course Title	L	T	P	Credits	Cat. Code
1	ME5301	CNC Systems and Programming	4	0	0	4	PCC
2	ME5302	Integrated Production Control Systems	4	0	0	4	PCC
3	ME5303	Mechatronics and MEMS	4	0	0	4	PCC
4	ME5404	Advanced CAD	4	0	0	4	PCC
5		Elective 1	3	0	0	3	DEC
6		Elective 2	3	0	0	3	DEC
7	ME5304	Mechatronics and Automation Laboratory	0	0	3	2	PCC
8	ME5406	CAD Laboratory	0	0	3	2	PCC
		To	22	0	6	26	

I – Year, II - Semester

S. No.	Course Co	Course Title	L	T	P	Credits	Cat. Co
1	ME5351	Computer Integrated Manufacturing	4	0	0	4	PCC
2	ME5352	Product Life Cycle Management	4	0	0	4	PCC
3	ME5353	Modeling and Simulation of Manufacturi Systems	4	0	0	4	PCC
4		Elective 3	3	0	0	3	DEC
5		Elective 4	3	0	0	3	DEC
6		Elective 5	3	0	0	3	DEC
7	ME5354	Manufacturing Simulation Laboratory	0	0	3	2	PCC
8	ME5255	CNC Laboratory	0	0	3	2	PCC
9	ME5291	Seminar	0	0	3	2	PCC
		To	21	0	9	27	

II – Year, I - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	ME5342	Comprehensive Viva-voce	0	0	0	4	PCC
2	ME5349	Dissertation Part-A	0	0	0	8	PCC
		To	0	0	0	12	

II – Year, II - Semester

S. No	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	ME5399	Dissertation Part-B	0	0	0	18	PCC
		To	**0**	**0**	**0**	**18**	

LIST OF ELECTIVES

I Year I Semester

ME5311	Business Intelligence
ME5312	Robotics
ME5313	Enterprise Resource Planning
ME5314	Soft Computing Techniques
ME5315	Computer Aided Inspection Systems
ME5211	Rapid Manufacturing Processes

I Year II Semester

ME5361	Supply Chain Management
ME5362	Design and Analysis of Experiments
ME5363	Flexible Manufacturing Systems
ME5364	Lean Manufacturing Systems
ME5365	Concurrent Engineering
ME5366	Artificial Intelligence in CIM
ME5367	Computer Networks for Manufacturing
ME5368	Product Design for Manufacturing and Assembly
ME5471	Finite Element Analysis

DETAILED SYLLABUS

ME 5301	CNC SYSTEMS AND PROGRAMMING	PCC	4-0-0	4

PRE-REQUISITES: None

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1.	Classify and distinguish NC, CNC and DNC systems.
CO2.	Develop manual and APT part programs for 2D complex profiles and test the program through simulation.
CO3.	Understand CNC machine structures and system drives.
CO4.	Develop interpolation algorithms for control loops.
CO5.	Understand latest developments in CNC system.

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	2	1	-	-	-	-	-	1	1
CO2	2	2	1	2	-	-	-	-	-	1	1
CO3	2	3	2	3	-	-	-	-	-	1	1
CO4	1	2	1	1	-	-	-	-	-	1	1
CO5	1	2	2	1	-	-	-	-	-	1	1

DETAILED SYLLABUS:

NC/CNC machine tools: An introduction, Clarification, Merits and demerits, Application.

Design of CNC: An introduction, Conventional machine tool design, Modern machine tool design, Tooling for CNC systems, Coordinate system in CNC machine tools

CNC programming: An introduction, Manual part programming such as Drilling, milling, turning etc.. Computer aided part programming (APT) Structure, APT language with examples.

Drive systems: Types of motors and their salient features, Feedback devices

Interpolators: Hardware and soft ware Interpolators, NC/CNC controllers

DNC systems: Classifications, Merits and demerits

Adaptive systems: Adaptive control with optimizations(ACO), Adaptive control with constraints(ACC)

Modern trends in CNC system: Machining centre and Turning centre, Communication networking in Manufacturing

READING:

1. James V. Valentino and Joseph Goldenberg, *Introduction to Computer Numerical Control*, 5th Edition, Prentice Hall, Englewood Cliff, New Jersey, 2012.

2. David Gibbs and Thomas Crandall, *CNC Machining and Programming: An Introduction*, Industrial Press Inc., 2003.
3. Yoram Koren, *Computer control of Manufacturing Systems*, McGraw Hill International, Singapore, 2006

ME5302	INTEGRATED PRODUCTION CONTROL SYSTEMS	PCC	4-0-0	4

PRE-REQUISITES: None

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1	Identify key decision areas for operations managers and researchers for design of production planning and control systems
CO2	Formulate competitive priorities and manufacturing strategy for a given production system to derive strategic advantage.
CO3	Apply ROP, MRP and JIT systems for inventory control in production systems.
CO4	Design push and pull systems using the principles of factory dynamics.
CO5	Design factory systems for shop floor control, production scheduling, aggregate planning and capacity planning.

CO-PO MPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	1	2	1	1	2	1	2	1	1
CO2	3	3	1	1	1	-	1	-	1	1	1
CO3	3	3	2	-	3	-	-	-	1	1	1
CO4	3	3	2	-	2	-	-	-	-	-	1
CO5	3	3	2	-	2	1	1	-	-	-	1

DETAILED SYLLABUS:

Introduction: Competitive dimensions, order qualifiers & winners, manufacturing systems characterization, manufacturing strategy;

Inventory Control: EOQ, dynamic lot sizing, statistical inventory control models;

Materials Requirements Planning (MRP): Concept of dependent demand, structure of MRP system, MRP calculations, planning & implementation issues, MRP-II & ERP;

Just-In-Time (JIT) Manufacturing: Origin & goals, small lot production, stable MPS, kanban control, vendor participation, continuous improvement, strategic implications of JIT system;

Factory Dynamics: Little' law, concept of effective processing time, flow variability, blocking, influence of variability;

Push and Pull Control Systems: Concept of push and pull control, benefits of pull control, CONWIP & DBR systems;

Pull Planning Framework: Demand management, capacity planning, aggregate planning, production scheduling, shop floor control, synthesis.

READING:

1. Krajewski U and Ritzman LP, Operations Management: Strategy and Analysis, Pearson Education Pvt. Ltd., Singapore, 2002.
2. Chase RB, Aquilano NJ and Jacobs RF, Operations Management for Competitive Advantage, McGraw-Hill Book Company, NY, 2005.
3. Hopp WJ and Spearman ML, Factory Physics: Foundations of Manufacturing Management, McGraw-Hill, NY, 2001.

ME5303	MECHATRONICS AND MEMS	PCC	4-0-0	4

PRE-REQUISITES: None

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1	Generate conceptual design for Mechatronics products based on potential custome requirements
CO2	Select appropriate sensors and transducers and devise an instrumentation system fo collecting information about processes
CO3	Design a control system for effective functioning of Mechatronics systems using digita electronics, microprocessors, microcontrollers and programmable logic controllers
CO4	Determine the performance of a Mechatronics system
CO5	Understand MEMS fabrication techniques

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	3	2	2	2	-	-	1	2	-	1
CO2	1	-	2	2	-	1	-	1	2	-	1
CO3	2	2	2	-	2	-	-	1	1	-	1
CO4	-	2	3	2	1	-	-	1	1	-	1
CO5	1	1	1	-	-	1	1	-	-	-	1

DETAILED SYLLUBUS:

Overview of Mechatronics
Historical perspective, Definition, Applications, Block diagram of Mechatronic system, Functions of Mechatronics Systems, Systems Engineering, Verification Vs Validation, Benefits of mechatronics in manufacturing.

Electrical and Electronic Systems
Electrical circuits and Kirchhoff's laws, Network Theorems and AC circuit Analysis, Transformers, Analog Devices, Signal Conditioning, Digital Electronics, Data Acquisition systems.

Modeling, Analysis and Control of Physical Systems
Basics of System Modeling: LTI and LTV systems, Need for modeling, Types of modeling, Steps in modeling, Building blocks of models, Modelling of one and two degrees of freedom systems, Modeling of Electro-mechanical systems, Mechanical Systems, Fluid systems, Thermal systems; Dynamic Responses, System Transfer Functions, State Space Analysis and System Properties, Stability Analysis using Root Locus Method, Stability Analysis using Bode Plots, PID Controllers (with and without Time Delay)

Sensors and Actuators
Static characteristics of sensors and actuators, Position, Displacement and Proximity Sensors, Force and torque sensors, Pressure sensors, Flow sensors, Temperature sensors, Acceleration sensors, Level sensors, Light sensors, Smart material sensors, Micro and Nano sensors, Selection criteria for sensors, Actuators: Electrical Actuators (Solenoids, Relays, Diodes, Thyristors, Triacs, BJT, FET, DC motor, Servo motor, BLDC motor, AC motor, Stepper motors), Hydraulic and

Pneumatic actuators, Design of Hydraulic and Pneumatic circuits, Piezoelectric actuators, Shape memory alloys.

Microprocessors, Microcontrollers and Programmable Logic Controllers
Logic Concepts and Design, System Interfaces, Communication and Computer Networks, Fault Analysis in Mechatronic Systems, Synchronous and Asynchronous Sequential Systems, Architecture, Microcontrollers, Programmable Logic Controllers (PLCs): Architecture, Number Systems Basics of PLC Programming, Logics, Timers and Counters, Application on real time industrial automation systems.

Micro-Electro Mechanical Systems (MEMS)
History, Effect of scaling, Fabrication techniques: Oxidation, Sputter disposition, CVD, Lithography, Etching, Wafer bonding, LIGA, DRIE, Applications: Lab on chip

Case Studies
Design of pick and place robot, Car engine management system, Automated manufacturing system, Automatic camera, Automatic parking system, Safety devices and systems.

READING:

1. W. Bolton, Mechatronics, Electronic control systems in mechanical and electrical engineering, Pearson Education, 5/e, 2011.
2. James J Allen, Micro Electro Mechanical Systems Design, CRC Press Taylor & Francis group.
3. David G. Alcaiatore and Michel B. Histand, Introduction to Mechatronics and Measuring Systems, Mc. Graw Hill Int. Edition, 3/e, 2006.
4. Craig K. C. and Stolfi, F. R., Introduction to Mechatronic System Design with Applications, IEEE Educational Activities Department, 1994.
5. Robert H. Bishop. The Mechatronics Handbook, CRC Press, 2/e, 2007.

ME5404	ADVANCED CAD	PCC	4-0-0	4

PRE-REQUISITES: None

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1	Understand geometric transformation techniques in CAD.
CO2	Develop mathematical models to represent curves.
CO3	Design surface models for engineering applications.
CO4	Model engineering components using solid modeling techniques.
CO5	Design and analysis of engineering components.

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	-	-	-	-	-	-	-	-	1
CO2	3	2	-	-	-	1	-	-	-	-	2
CO3	3	2	-	1	-	2	-	-	-	-	2
CO4	3	2	2	3	-	2	-	-	2	-	2
CO5	3	3	3	3	-	2	-	-	3	-	2

DETAILED SYLLABUS:

Introduction to CAD: Introduction to CAD, CAD input devices, CAD output devices, CAD Software, Display Visualization Aids, and Requirements of Modelling.

2D Transformations of geometry: 2D Translation, 2D Scaling, 2D Reflection, 2D Rotation, Homogeneous representation of transformation, Concatenation of transformations.

3D Transformations of geometry and Projections: 3D Translation, 3D Scaling, 3D Reflection, 3D Rotation, Homogeneous representation of transformation, Concatenation of transformations, Perspective, Axonometric projections, Orthographic and Oblique projections.

Design of Curves: Analytic Curves, PC curve, Ferguson, Composite Ferguson, curve Trimming and Blending, Bezier segments, de Casteljau's algorithm, Bernstein polynomials, Bezier-subdivision, Degree elevation, Composite Bezier, Splines, Polynomial Splines, B-spline basis functions, Properties of basic functions, Knot Vector generation, NURBS.

Design of Surfaces: Differential geometry, Parametric representation, Curves on surface, Classification of points, Curvatures, Developable surfaces, Surfaces of revolution, Intersection of surfaces, Surface modelling, 16-point form, Coons patch, B-spline surfaces.

Design of Solids: Solid entities, Boolean operations, B-rep of Solid Modelling, CSG approach of solid modelling, Advanced modelling methods.

Data Exchange Formats and CAD Applications: Data exchange formats, Finite element analysis, reverse engineering, modelling with point cloud data,Rapid prototyping.

READING:

1. **Ibrahim Zeid and Sivasubramanian, R.,** CAD/CAM Theory and Practice, Tata McGraw Hill Publications, New Delhi, 2009.
2. **David F. Rogers, J. A. Adams,** Mathematical Elements for Computer Graphics, TMH, 2008.

ME 5311	BUSINESS INTELLIGENCE	DEC	3-0-0	3

PRE-REQUISITES: None

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1	Understand the components of BI decision-support development.
CO2	Evaluate enterprise infrastructure for BI implementation.
CO3	Understand the issues in BI Project planning, requirements and implementation.
CO4	Analyze meta data repository for data mining applications.

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	2	1	-	-	1	2	1	3	1	1
CO2	-	3	1	-	1	2	2	2	2	-	-
CO3	-	1	1	-	1	2	2	3	3	1	-
CO4	-	2	-	3	-	2	-	-	1	1	2

DETAILED SYLLABUS:

Introduction: BI definition, BI Decision Support Initiative, Development Approaches, Engineering Stages and the development steps, BI Project Team Structure.

Enterprise Infrastructure Evaluation: The Hardware Platform, The Middleware Platform, The DBMS Platform, Need for Nontechnical Infrastructure, Risks of Evaluation.

Project Requirements and Planning: Managing the BI Project, Project planning activities, Deliverables, General Business Requirement, The Interviewing Process, Data Analysis, Data Cleaning.

Application Prototyping: Purposes of Prototyping, Types of Prototypes, Building Successful Prototypes.

Meta Data Repository Analysis and Database Design: Importance of Meta Data, Meta Data Classifications, The Logical Model, Logical and Physical Data Base Design.

Application Development: Online Analytical Processing Tools, Multidimensional Analysis Factors, Online Analytical Processing Architecture, Development Environments, Application Development Activities, Deliverables Resulting from These Activities.

READING:

1. Larissa T Moss, Business Intelligence Roadmap, Addison-Wesley Information Technology Series, 2003.
2. Efraim Turban, Jay E. Aronson, Ting-Peng Liang, Ramesh Sharda, Decision Support and Business Intelligence Systems, 8th Edition, Prentice Hall, 2006.

ME 5312	ROBOTICS	DEC	3-0-0	3

PRE REQUISITES: None

COURSE OUTCOMES: At the end of the course, the student shall be able to

CO1	Classify robots based on joints and arm configurations.
CO2	Design application specific End Effectors for robots.
CO3	Compute forward and inverse kinematics of robots and determine trajectory plan.
CO4	Program robot to perform typical tasks including Pick and Place, Stacking and Welding
CO5	Design and select robots for Industrial and Non-Industrial applications.

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	1	1	-	-	-	-	-	1
CO2	3	3	3	2	1	2	1	-	1	-	1
CO3	3	3	3	2	1	1	1	-	1	-	1
CO4	2	2	2	2	1	1	1	2	1	1	1
CO5	3	3	3	2	1	1	1	2	1	1	1

DETAILED SYLLABUS:

Robotics classification, Sensors-Position sensors, Velocity sensors, Proximity sensors, Touch and Slip Sensors, Force and Torque sensors.

Grippers and Manipulators-Gripper joints, Gripper force, Serial manipulator, Parallel Manipulator, selection of Robot-Selection based on the Application

Kinematics-Manipulators Kinematics, Rotation Matrix, Homogenous Transformation Matrix, Direct and Inverse Kinematics for industrial robots for Position and orientation.

Differential Kinematics and static- Dynamics-Lagrangian Formulation, Newton-Euler Formulation for RR & RP Manipulators,

Trajectory planning-Motion Control- Interaction control, Rigid Body mechanics, Control architecture-position, path velocity and force control systems, computed torque control, adaptive control, and Servo system for robot control.

Programming of Robots and Vision System- overview of various programming languages.

Application of Robots in production systems- Application of robot in welding, machine tools, material handling, and assembly operations parts sorting and parts inspection.

READINGS:

1. Fu, K.S., Gonzalez, R.C., and Lee, C.S.G., *Robotics control, Sensing, Vision and Intelligence*, McGraw-Hill Publishing company, New Delhi, 2003.
2. Klafter, R.D., Chmielewski, T.A., and Negin. M, *Robot Engineering-An Integrated Approach*, Prentice Hall of India, New Delhi, 2002.
3. Craig, J.J., *Introduction to Robotics Mechanics and Control*, Addison Wesley, 1999.

ME5313	ENTERPRISE RESOURCE PLANNING	DEC	3-0-0	3

PRE-REQUISITES: ME5302 Integrated Production Control Systems

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1	Understand the risks and benefits of ERP.
CO2	Understand the technologies needed for ERP implementation.
CO3	Understand the implementation process..
CO4	Analyze the role of Consultants, Vendors and Employees.
CO5	Analyze the role of PLM, SCM and CRM in ERP.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	3	1	-	1	1	2	1	1	1	-
CO2	1	2	1	-	1	2	1	-	1	-	1
CO3	1	2	2	1	1	2	2	1	2	1	-
CO4	-	1	2	-	2	2	1	2	1	-	-
CO5	1	1	1	1	1	1	1	1	1	-	-

DETAILED SYLLABUS:

Introduction to ERP: Enterprise – an overview, brief history of ERP, common ERP myths, Role of CIO, Basic concepts of ERP, Risk factors of ERP implementation, Operation and Maintenance issues, Managing risk on ERP projects.

ERP and Related Technologies: BPR, Data Warehousing, Data Mining, OLAP, PLM, SCM, CRM, GIS, Intranets, Extranets, Middleware, Computer Security, Functional Modules of ERP Software, Integration of ERP, SCM and CRM applications.

ERP Implementation: Why ERP, ERP Implementation Life Cycle, ERP Package Selection, ERP Transition Strategies, ERP Implementation Process, ERP Project Teams.

ERP Operation and Maintenance: Role of Consultants, Vendors and Employees, Successes and Failure factors of ERP implementation, Maximizing the ERP system, ERP and eBusiness, Future Directions and Trends.

READING:

1. Alexis Leon, Enterprise Resource Planning, Tata McGraw Hill, Second Edition, 2008.
2. Jagan Nathan Vaman, ERP in Practice, Tata McGraw Hill, 2007.
3. Carol A Ptak, ERP: Tools, Techniques, and Applications for Integrating the Supply Chain, 2nd Edition, CRC Press, 2003.

ME 5314	SOFT COMPUTING TECHNIQUES	DEC	3-0-0	3

PRE REQUISITES: None

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1	Differentiate and classify traditional and non-traditional optimization methods.
CO2	Formulate an optimization problem to solve complex manufacturing engineering problems
CO3	Apply A*, AO*, Branch and Bound search techniques for problem solving.
CO4	Apply GA, PSO and ACO algorithms for problems in scheduling, process planning an layout design.

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	1	2	-	-	-	-	1	1
CO2	2	2	2	1	2	-	-	-	-	1	1
CO3	1	2	2	1	2	1	1	-	-	1	1
CO4	2	2	2	2	3	1	1	1	1	-	1

DETAILED SYLLABUS:

1. **Problem Solving Methods and Tools**: Problem Space, Problem solving, State space, Algorithm’s performance and complexity, Search Algorithms, Depth first search method, Breadth first search methods their comparison, A*, AO*, Branch and Bound search techniques, p type, Np complete and Np Hard problems.

2. **Evolutionary Computing Methods:** Principles of Evolutionary Processes and genetics, A history of Evolutionary computation and introduction to evolutionary algorithms, Genetic algorithms, Evolutionary strategy, Evolutionary programming, Genetic programming.

3. **Genetic Algorithm and Genetic Programming:** Basic concepts, working principle, procedures of GA, flow chart of GA, Genetic representations, (encoding) Initialization and selection, Genetic operators, Mutation, Generational Cycle, applications.

4. **Swarm Optimization**: Introduction to Swarm intelligence, Ant colony optimization (ACO), Particle swarm optimization (PSO), Artificial Bee colony algorithm (ABC), Other variants of swarm intelligence algorithms.

5. **Advances in Soft Computing Tools:** Fuzzy Logic, Theory and applications, Fuzzy Neural networks, Pattern Recognition, Differential Evolution, Data Mining Concepts, Applications of above algorithms in manufacturing engineering problems.

6. **Artificial Neural Networks:** Neuron, Nerve structure and synapse, Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Back propagation algorithm, factors affecting back propagation training, applications.

7. **Application of Soft Computing to Mechanical Engineering/Production Engineering Problems:** Application to Inventory control, Scheduling problems, Production 1Distribution, Routing, Transportation, Assignment problems.

READING:

1. Tettamanzi Andrea, Tomassini and Marco, *Soft Computing Integrating Evolutionary, Neural and Fuzzy Systems*, Springer, 2001.
2. Elaine Rich, *Artificial Intelligence*, McGraw Hill, 2/e, 1990.
3. Kalyanmoy Deb, *Multi-objective Optimization using Evolutionary Algorithms*, John Wiley and Sons, 2001.

ME 5315	COMPUTER AIDED INSPECTION SYSTEMS	DEC	3-0-0	3

PRE-REQUISITES: None

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1	Understand the role of computers in metrology.
CO2	Apply the concepts of calibration, traceability and uncertainty for accurate and reliabl measurements.
CO3	Identify and estimate measurement errors and suggest suitable techniques to minimiz them.
CO4	Understand the methods and devices for dimensional measurements.
CO5	Assess surface roughness and form errors.

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	-	-	-	1	-	-	-	1	-	1
CO2	1	-	1	1	1	-	-	-	1	-	1
CO3	1	-	1	1	1	-	-	-	1	-	1
CO4	2	-	2	2	1	-	-	-	1	-	1
CO5	2	-	2	2	1	-	-	-	1	-	1

DETAILED SYLLABUS:

General Concepts
Generalized measurement system, Basic terminology, Errors in measurement, Calibration, Uncertainty.

Linear and Angular Measurements
Standards for length measurement, Length measuring instruments, Angle measuring instruments, Setting errors with sine-bar, Measurement of angles over 45^0, Internal taper measurements.

Amplifying Devices
Tool Maker’s microscope, Profile projector, Comparators: Mechanical, Pneumatic, optical, electric and electronic.

Gear and Screw Thread Measurements
Gear measurement: Classification of gears, Forms of gear teeth, Gear tooth terminology, Methods of measuring tooth thickness, tooth profile & pitch, Gear Errors. Screw Thread Measurement: Terminology, Forms of thread, Errors in threads, Measurement of major, minor and effective diameters (2-wire and 3-wire methods)

Surface Roughness Measurement
Components of surface texture, Need for surface roughness measurement, Measurement of surface roughness, Roughness characterization, Roughness grades.

Geometric Form Measurement
Importance, Indication, Intrinsic and Extrinsic methods, Roundness, Straightness, Flatness, Cylindricity, Squareness, Parallelism, Run out and concentricity.

Computer Aided Inspection
In-process Inspection and On-line Sensing, Lasers in Metrology, Automated Inspection Techniques, Coordinate Measuring Machine (CMM), Image processing and its application in Metrology.

READING:

1. M. Mahajan, *A text-book of Metrology*, DhanpatRai& Co, 2009.
2. K. J. Hume, *Engineering Metrology*, 1970, Mc Donald & Co (Publishers), London
3. J.F.W. Galyer and C.R.Shotbolt, *Metrology for Engineers*, ELBS Edition, 5/e, 1993.
4. Thomas. G. G, *Engineering Metrology*, Butterworth PUB.1974.
5. R.K.Jain, *Engineering Metrology*, Khanna Publishers, 19/e, 2005.

ME5211	RAPID MANUFACTURING PROCESSES	DEC	3-0-0	3

PRE-REQUISITES: None

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1	Identify the need for reduction of product development time.
CO2	Model any complex part for rapid manufacture.
CO3	Illustrate the working principles of rapid manufacturing technologies.
CO4	Select the rapid manufacturing process to fabricate a given product.
CO5	Identify and minimize errors that occur during conversion of CAD models.
CO6	Optimize the responses in rapid manufacturing process to improve the quality of parts.

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	-	2	1	1	3	-	-	1	-
CO2	3	3	-	3	3	2	2	-	-	2	-
CO3	1	2	-	3	3	1	2	-	-	2	-
CO4	2	3	-	3	2	2	2	-	-	2	-
CO5	2	2	-	3	3	2	2	-	-	1	-
CO6	2	2	-	3	3	2	2	-	-	1	-

DETAILED SYLLABUS:

Introduction: Introduction to Prototyping, Traditional Prototyping Vs. Rapid Prototyping (RP), Need for time compression in product development, Usage of RP parts, Generic RP process, Distinction between RP and CNC, other related technologies, Classification of RP.

RP Software: Need for RP software, MIMICS, Magics, SurgiGuide, 3-matic, 3D-Doctor, Simplant, Velocity2, VoXim, SolidView, 3DView, etc., software, Preparation of CAD models, Problems with STL files, STL file manipulation, RP data formats: SLC, CLI, RPI, LEAF, IGES, HP/GL, CT, STEP.

Photopolymerization RP Processes: Stereolithography (SL), SL resin curing process, SL scan patterns, Microstereolithography, Applications of Photopolymerization Processes.

Powder Bed Fusion RP Processes: Selective laser Sintering (SLS), Powder fusion mechanism and powder handling, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Applications of Powder Bed Fusion Processes.

Extrusion-Based RP Systems: Fused Deposition Modelling (FDM), Principles, Plotting and path control, Applications of Extrusion-Based Processes.

Printing RP Processes: 3D printing (3DP), Research achievements in printing deposition, Technical challenges in printing, Printing process modelling, Applications of Printing Processes.

Sheet Lamination RP Processes: Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications.

Beam Deposition RP Processes: Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Processing-structure-properties, relationships, Benefits and drawbacks.

Rapid Tooling: Conventional Tooling Vs. Rapid Tooling, Classification of Rapid Tooling, Direct and Indirect Tooling Methods, Soft and Hard Tooling methods.

Reverse Engineering: Reverse Engineering (RE) Methodologies and Techniques, Selection of RE systems, RE software, RE hardware, RE in product development.

Errors in RP Processes: Pre-processing, processing, post-processing errors, Part building errors in SLA, SLS, etc.

RP Applications: Design, Engineering Analysis and planning applications, Rapid Tooling, Reverse Engineering, Medical Applications of RP.

READING:

1. **Chua Chee Kai., Leong Kah Fai., Chu Sing Lim,** Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific, 2010.
2. **Ian Gibson., David W Rosen., Brent Stucker**., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010.
3. **RafiqNoorani,** Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons, 2006.

ME5304	MECHATRONICS AND AUTOMATION LAB	PCC	*0-0-3*	*2*

PRE-REQUISITES: None

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1.	Measure load, displacement and temperature using analogue and digital sensors.
CO2.	Develop PLC programs for control of traffic lights, water level, lift and conveyor belt.
CO3.	Develop P89V51RD2 microcontroller program to guide a robot in a given arena.
CO4.	Simulate and analyse PD, PI and PID controllers for a given physical system usin MATLAB.
CO5.	Develop pneumatic and hydraulic circuits using Automaton studio.

CO-PO MAPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	3	2	-	-	-	3	1	1	1
CO2	2	-	3	1	3	-	-	1	3	1	1
CO3	2	-	3	1	3	-	-	1	2	1	1
CO4	2	-	3	3	3	-	-	3	2	1	1
CO5	2	-	3	1	3	-	-	2	1	1	1

LIST OF EXPERIMENTS

1. **DYNA 1750 Transducers Kit :-**
   I. Characteristics of LVDT
   II. Principle & Characteristics of Strain Gauge
   III. Characteristics of Summing Amplifier
   IV. Characteristics of Reflective Opto Transducer

2. **Mobile Robot with P89V51RD2 microcontroller**
   I. Program for Operating Buzzer Beep
   II. Program for Operating Motion control
   III. Program for Operating Direction control
   IV. Program for Operating White line follower for the given arena

3. **PLC PROGRAMMING**
   I. Ladder programming on Logic gates ,Timers & counters
   II. Ladder Programming for digital & Analogy sensors
   III. Ladder programming for Traffic Light control, Water level control and Lift control Modules

4. **AUTOMATION STUDIO software**
   I. Introduction to Automation studio & its control
   II. Draw & Simulate the Hydraulic circuit for series & parallel cylinders connection
   III. Draw & Simulate Meter-in, Meter-out and hydraulic press and clamping.

5. **MATLAB Programming**
   I. Sample programmes on Mat lab
   II. Simulation and analysis of PID controller using SIMULINK

ME5406	**CAD LABORATORY**	*PCC*	*0-0-3*	*2*

PRE-REQUISITES: None

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1	Develop Auto LISP programs for drawing machine elements.
CO2	Develop codes for analytical and synthetic curves.
CO3	Draw machine elements in sketcher, part and assembly modes.
CO4	Generate automated tool paths and G-codes for machining components.
CO5	Validate DXF, IGES and STEP formats for exchange of CAD files.

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	1	-	1	-	-	-	-	2
CO2	3	3	-	2	-	2	-	-	-	-	1
CO3	3	3	-	2	-	2	-	-	2	-	2
CO4	3	3	-	3	-	2	-	-	3	-	3
CO5	3	3	-	3	-	2	-	-	2	-	3

DETAILED SYLLABUS

1. Introduction and Installation of CAD/CAM/CAE Softwares
2. Introduction to Solid Modelling & Pro/E Package
3. Working with sketch mode of Pro/E
4. Introduction to MATLAB Programming
5. Working with creating features (Extrude & Revolve)
6. Working Datum Planes
7. Working with the tools like Hole, Round, Chamfer and Rib
8. Working with the tools like Pattern, Copy, Rotate, Move and Mirror
9. Working with advanced modeling tools (Sweep, Blend & Swept Blend)
10. Assembly modelling in Pro/E
11. Generating, editing and modifying drawings in Pro/E
12. Exercises on Analytic Curves (Lines, Circles, Ellipses, Parabolas, Hyperbolas, Conics) using MATLAB Programming
12. Exercises on Synthetic Curves (Cubic Spines, Bezier Cures, B-Spine Curves) using MATLAB Programming
14. Working with CAD Data Exchange formats: IGES,ACIS, DXF and STL

ME5351	COMPUTER INTEGRATED MANUFACTURING	PCC	4-0-0	4

PRE REQUISITES: None

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1	*Understand the effect of manufacturing automation strategies and derive productio metrics.*
CO2	*Analyze automated flow lines and assembly systems, and balance the line.*
CO3	*Design automated material handling and storage systems for a typical production systen*
CO4	*Design a manufacturing cell and cellular manufacturing system.*
CO5	*Develop CAPP systems for rotational and prismatic parts.*

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	-	1	2	-	-	1	1	1	1
CO2	3	3	1	1	2	-	-	1	-	1	1
CO3	2	2	3	2	2	2	1	-	-	1	1
CO4	2	2	3	2	2	2	1	-	-	1	1
CO5	2	2	2	3	3	2	-	-	-	1	-

DETAILED SYLLABUS:

Manufacturing Automation: Automated Manufacturing Systems, Computerized Manufacturing Support Systems, Reasons for Automation, Automation Strategies-The USA Principle, Ten Strategies for Automation and Process Improvement, Automation Migration Strategy.

Automated Flow lines: System Configurations, Workpart Transfer Mechanisms, Storage Buffers, Control of Production Line, Analysis of Transfer Lines-Transfer Lines with No Internal Parts Storage, Transfer Lines with Internal Storage Buffers.
Manual Assembly Lines: Assembly Workstations, Work Transport Systems, Line Pacing, Coping With Product Variety, Analysis of Single Model Assembly Lines-Repositioning Losses, The Line Balancing Problem, Line Balancing Algorithms-Largest Candiate Rule, Kilbridge and Wester Method, Ranked Positional Weights Method.

Automated Assembly Systems: System Configurations, Parts Delivery at Workstations, Applications, Quantitative Analysis of Assembly Systems- Parts Delivery System at Workstations, Multi-station Assembly machines, Single Station Assembly Machines, Partial Automation.

Automatic Material Handling and Storage systems: Design Considerations in Material Handling, Material Transport Equipment-Industrial Trucks, Automated Guided Vehicles, Monorails and Other Rail-Guided Vehicles, Conveyors, Cranes and Hoists, Analysis of Vehicle Based Systems, Conveyor Analysis. Automated Storage/Retrieval Systems, Carousel Storage Systems, Engineering Analysis of AS/RS and Carousel Systems.

Automated Inspection systems: Overview of Automated Identification Methods, Bar Code Technology, Radio Frequency Identification, Other AIDC Technologies-Mangnetic Stripes, Optical Character Recognition, and Machine Vision.

Cellular Manufacturing Systems: Part Families, Parts Classification and Coding, Features of Parts Classification and Coding Systems, Opitz of Parts Classification and Coding Systems, Production Flow Analysis, Composite Part Concept, Machine Cell Design, Applications Of Group Technology, Quantitative analysis of Cellular Manufacturing, Grouping of parts and Machines by Rank Order Clustering, Arranging Machines in a GT Cell.

Computer Aided Process Planning: Retrieval CAPP Systems, Generative CAPP Systems, Feature Identification- Algorithms, Graph Based Approach, Attribute Adjacency Graph, Benefits of CAPP.

Flexible Manufacturing Systems: Flexibility, Types Of FMS-A Dedicated FMS, A Random Order FMS, FMS Components-Workstations, Material Handling and Storage Systems, Computer Control System, Human Recourses, FMS Applications and Benefits

Computer Integrated Manufacturing: The Scope of CAD/CAM and CIM, Computerized elements of a CIM System, Components of CIM, Database for CIM, Planning , Scheduling and Analysis of CIM Systems.

READING:

1. Mikell P Groover, *Automation, production Systems and Computer Integrated Manufacturing,* 3rd Edition, Prentice Hall Inc., New Delhi, 2007.
2. Nanua Singh, *System Approach to Computer Integrated Manufacturing,* Wiley & Sons Inc., 1996.
3. Andrew Kusiak, *Intelligent Manufacturing System,* Prentice Hall Inc., New Jersey, 1992.

ME5352	PRODUCT LIFE CYCLE MANAGEMENT	PCC	4-0-0	4

PRE REQUISITES: None

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1	Understand product data, information, structures and PLM concepts.
CO2	Apply PLM systems in organization verticals including production, after sales, sales an marketing, and subcontracting.
CO3	Measure benefits of PLM implementation in daily operations, material costs, productivit of labour and quality costs.
CO4	Apply PLM concepts for service industry and E-Business.
CO5	Recognize tools and standards in PLM.

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	2	2	2	1	-	-	1	1	1
CO2	2	2	1	2	2	2	2	2	2	3	1
CO3	1	2	2	2	3	2	1	1	2	3	1
CO4	1	1	2	2	3	2	1	1	2	3	1
CO5	1	-	1	2	3	2	1	1	1	1	1

DETAILED SYLLABUS:

Fundamentals of PLM: Product data or Product information, Product lifecycle management concept, Information models and product structures-Information model, The product information (data) model, The product model, Reasons for the deployment of PLM systems.

Enterprise solution with PLM: Use of product lifecycle management systems in different organization verticals, Product development and engineering, Impact of Manufacturing with PLM-Challenges of product management in the engineering and manufacturing industry, Life cycle thinking, value added services and after sales, Case 1: Electronics manufacturer, Case 2: An engineering product.

Product Structures: Standardized product data and materials data model, Product structure of a ship, Product structure of a customizable product, Product structure of a configurable service product.

PLM service information model: Categorizing services , Rational for building service products, How to make a service more like a tangible product?, Making items out of product functions, PLM challenges in service business, An IT-service provider and a customer-specifically variable product.

PLM for e-manufacturing: electronic business and PLM, Preconditions for electric business from the viewpoint of the individual company, Significance of product management, collaboration and electronic business for the manufacturing industry.

Integration of the PLM system with other applications: Different ways to integrate PLM systems, Transfer file, Database integration, System roles, ERP, Optimization of ERP for PLM and CAD.

Implementing end to end business process management: Product lifecycle management as a business strategy tool, Product lifecycle management as an enabler of cooperation between companies, Contents of collaboration, Successful cooperation, Tools of collaboration, From changes in the business environment to product strategy, Business Benefits of PLM.

PLM applications in process and product industries examples: Case 1: Electronics manufacturer, Case 2: An engineering product, Case 3: Capital goods manufacturer and customer-specifically variable product, Case 4: An IT-service provider and a customer-specifically variable product.

READING:

1. Jaya Krishna S, *Product Lifecycle Management: Concepts and cases*, ICFAI Publications 2011.
2. *SOA approach to Enterprise Integration for Product Lifecycle*, IBM Red books, 2011.

ME5353	MODELING AND SIMULATION OF MANUFACTURING SYSTEMS	*PCC*	*4-0-0*	*4*

PRE-REQUISITES: None

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1.	Classify simulation and analytical models used in manufacturing system environment
CO2.	Review of probability and simulation languages
CO3.	Design and evaluate a given manufacturing system using simulation
CO4.	Generate random numbers and variants to execute a simulation model
CO5.	Evaluate queuing networks and markov chains in the context of manufacturing

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	2	1	-	-	-	-	-	1	1
CO2	2	2	2	2	-	-	-	-	-	1	1
CO3	2	2	2	3	-	-	-	-	-	1	1
CO4	1	1	2	2	-	-	-	-	-	1	1
CO5	1	1	1	1	-	-	-	-	-	1	1

DETAILED SYLLABUS:

Introduction to System and simulation: Concept of system and elements of system, Discrete and continuous system, Models of system and Principles of modeling and simulation, Monte carlo simulation, Types of simulation, Steps in simulation model, Advantages, limitations and applications of simulation, Applications of simulation in manufacturing system

Review of statistics and probability: Types of discrete and continuous probability distributions such as Geometric, Poisson, Uniform, Geometric distribution with examples, Normal, Exponential distribution with examples

Random numbers: Need for RNs, Technique for Random number generation such as Mid product method, Mid square method, and Linear congruential method with examples

Test for Random numbers: Uniformity - Chi square test or Kolmogorov Smirnov test, Independency- Auto correlation test

Random Variate generation: Technique for Random variate generation such as Inverse transforms technique or Rejection method

Analysis of simulation data: Input data analysis, Verification and validation of simulation models, Output data analysis

Simulation languages: History of simulation languages, Comparison and selection of simulation languages

Design and evaluation of simulation experiments: Development and analysis of simulation models using simulation language with different manufacturing systems

Queueing models: An introduction**,** M/M/1 and M/M/m Models with examples, Open Queueing and Closed queueing network with examples

Markov chain models and others: Discrete time markov chain with examples, Continues time markov chain with examples, stochastic process in manufacturing, Game theory

READING:

1. J.Banks, J.S. Carson, B. L. Nelson and D.M. Nicol, “Discrete Event System Simulation”, PHI, New Delhi, 2009.
2. A.M. Law and W.D.Kelton, “Simulation Modeling and Analysis”, Tata McGraw Hill Ltd, New Delhi, 2008.
3. N. Viswanadham and Y. Narahari, "Performance Modeling of Automated Manufacturing Systems", PHI, New Delhi, 2007.

ME5361	SUPPLY CHAIN MANAGEMENT	DEC	3-0-0	3

PRE-REQUISITES: ME5302 Integrated Production Control Systems

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1	Understand the decision phases and apply competitive and supply chain strategies.
CO2	Understand drivers of supply chain performance.
CO3	Analyze factors influencing network design.
CO4	Analyze the role of forecasting in a supply chain
CO5	Understand the role of aggregate planning, inventory, IT and coordination in a suppl chain.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	1	1	-	2	2	1	2	2	1	-
CO2	1	3	2	-	2	1	1	2	2	1	-
CO3	1	2	1	-	-	-	1	-	1	1	1
CO4	1	1	2	1	1	1	-	-	1	-	1
CO5	1	-	1	1	2	1	2	1	1	1	2

DETAILED SYLLABUS:

Strategic Framework: Introduction to Supply Chain Management, Decision phases in a supply chain, Process views of a supply chain: push/pull and cycle views, Achieving Strategic fit, Expanding strategic scope.
Supply Chain Drivers and Metrics: Drivers of supply chain performance, Framework for structuring Drivers, Obstacles to achieving strategic fit.
Designing Supply Chain Network: Factors influencing Distribution Network Design, Design options for a Distribution network, E-Business and Distribution network, Framework for Network Design Decisions, Models for Facility Location and Capacity Allocation.
Forecasting in SC: Role of forecasting in a supply chain, Components of a forecast and forecasting methods, Risk management in forecasting.
Aggregate Planning and Inventories in SC: Aggregate planning problem in SC, Aggregate Planning Strategies, Planning Supply and Demand in a SC, Managing uncertainty in a SC: Safety Inventory.
Coordination in SC: Modes of Transportation and their performance characteristics, Supply Chain IT framework, Coordination in a SC and Bullwhip Effect.

READING:

1. Sunil Chopra and Peter Meindl, Supply Chain Management - Strategy, Planning and Operation, 4th Edition, Pearson Education Asia, 2010.
2. David Simchi-Levi, PhilpKamintry and Edith Simchy Levy, Designing and Managing the Supply Chain - Concepts Strategies and Case Studies, 2nd Edition, Tata-McGraw Hill, 2000.

ME5362	DESIGN AND ANALYSIS OF EXPERIMENTS	DEC	3-0-0	3

PREREQUISITES: None

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1	Formulate objective(s) and identify key factors in designing experiments for a give problem.
CO2	Develop appropriate experimental design to conduct experiments for a given problem.
CO3	Analyze experimental data to derive valid conclusions.
CO4	Optimize process conditions by developing empirical models using experimental data.
CO5	Design robust products and processes using parameter design approach.

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	3	-	3	-	-	-	-	1	-	1
CO2	-	3	-	3	-	-	-	-	1	-	1
CO3	-	3	-	3	-	-	-	-	1	-	1
CO4	-	3	-	3	-	-	-	-	1	-	1
CO5	-	3	-	3	-	-	-	-	1	-	1

DETAILED SYLLABUS:

Fundamentals of Experimentation: Role of experimentation in rapid scientific progress, Historical perspective of experimental approaches, Steps in experimentation, Principles of experimentation;

Simple Comparative Experiments: Basic concepts of probability and statistics, Comparison of two means and two variances, Comparison of multiple (more than two) means & ANOVA;

Experimental Designs: Factorial designs, fractional factorial designs, orthogonal arrays, standard orthogonal arrays & interaction tables, modifying the orthogonal arrays, selection of suitable orthogonal array design, analysis of experimental data;

Response Surface Methodology: Concept, linear model, steepest ascent, second order model, regression;

Taguchi's Parameter Design: Concept of robustness, noise factors, objective function & S/N ratios, inner-array and outer-array design, data analysis.

READING:

1. Montgomery DC, Design and Analysis of Experiments, 7th Edition, John Wiley & Sons, NY, 2008.
2. Ross PJ, Taguchi Techniques for Quality Engineering, McGraw-Hill Book Company, NY, 2008.

ME5363	FLEXIBLE MANUFACTURING SYSTEMS	DEC	3-0-0	3

PRE-REQUISITES: None

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1.	Classify and distinguish FMS and other manufacturing systems including job-shop an mass production systems.
CO2.	Explain processing stations and material handling systems used in FMS environments.
CO3.	Design and analyze FMS using simulation and analytical techniques.
CO4.	Understand tool management in FMS.
CO5.	Analyze the production management problems in planning, loading, scheduling, routing and breakdown in a typical FMS.

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	1	1						1	1
CO2	3	2	1	1						1	1
CO3	3	3	2	2							1
CO4	1	2	1	2						1	1
CO5	3	2	3	3						1	1

DETAILED SYLLABUS:

Understanding of FMS: Evolution of Manufacturing Systems, Definition, objective and Need, Components, Merits, Demerits and Applications Flexibility in Pull and Push type
Classification of FMS Layout: Layouts and their Salient features, Single line, dual line, loop, ladder, robot centre type etc.
Processing stations: Salient features Machining Centers, Turning centre, Coordinate measuring machine (CMM), Washing/ Deburring station
Material Handling System: An introduction, Conveyor, Robots, Automated Guided Vehicle (AGV), Automated Storage Retrieval System (ASRS)
Management technology: Tool Management, tool magazine, Tool preset, identification, Tool monitoring and fault detection, routing, Production Planning and Control, Scheduling and loading of FMS
Design of FMS: Performance Evaluation of FMS, Analytical model and Simulation model of FMS
Case studies: Typical FMS problems from research papers

READINGS:

1. William W Luggen, "Flexible Manufacturing Cells and System" Prentice Hall of Inc New Jersey, 1991
2. Reza A Maleki "Flexible Manufacturing system" Prentice Hall of Inc New Jersey, 1991
3. John E Lenz "Flexible Manufacturing" marcel Dekker Inc New York ,1989.
4. Groover, M.P "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India Pvt.Ltd. New Delhi 2009

ME5364	LEAN MANUFACTURING SYSTEMS	DEC	3-0-0	3

PRE-REQUISITES: ME5302 Integrated Production Control System

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1	Understand the concepts in Lean Manufacturing.
CO2	Understand the tools and methods of Lean Manufacturing.
CO3	Analyze the issues in Lean implementation.
CO4	Distinguish Lean with TPS, ERP and ISO 9001:2000.

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	2	2	-	2	1	3	2	2	3	-
CO2	-	3	2	-	2	2	1	2	2	2	-
CO3	-	2	2	1	1	2	2	2	2	2	-
CO4	-	-	-	-	-	2	2	1	1	2	2

DETAILED SYLLABUS:

Introduction to lean manufacturing: Objectives of lean manufacturing-key principles and implications of lean manufacturing- traditional Vs lean manufacturing.

Lean manufacturing concepts: Value creation and waste elimination- main kinds of waste- pull production-different models of pull production-continuous flow-continuous improvement / Kaizen-worker involvement -cellular layout- administrative lean.

Lean manufacturing tools and methodologies: Standard work -communication of standard work to employees -standard work and flexibility -visual controls-quality at the source- 5S principles -preventative maintenance-total quality management-total productive maintenance -changeover/setup time -batch size reduction -production leveling.

Value stream mapping: The as-is diagram-the future state map-application to the factory simulation scenario-line balancing -Poke Yoke -Kanban – overall equipment effectiveness.

Just in time manufacturing: Introduction - elements of JIT - uniform production rate - pull versus push method- Kanban system - small lot size - quick, inexpensive set-up - continuous improvement. Optimised production technology.

One-piece flow: Process razing techniques – cells for assembly line – case studies.

Implementing lean: Road map-senior management Involvement-best practices.

Reconciling lean with other systems: Toyota production system-lean six sigma-lean and ERP-lean with ISO9001:2000.

READING:

1. Askin R G and Goldberg J B, Design and Analysis of Lean Production Systems, John Wiley and Sons Inc., 2003.
2. Micheal Wader, Lean Tools: A Pocket Guide to Implementing Lean Practices, Productivity and Quality Publishing Pvt Ltd, 2002.
3. Richard B Chase F Robert Jacobs and Nicholas J Aquilano, Operations Management for Competitive Advantage, 10th Edition, McGraw Hill/Irwin, 2003.
4. Masaaki Sato, The Toyota Leaders – An Executive Guide, Vertical Inc, New York, 2008.

ME5365	CONCURRENT ENGINEERING	DEC	3-0-0	3

PRE REQUISITES: None

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1	Understand the need of concurrent engineering and strategic approaches for product design.
CO2	Apply concurrent design principles to product design.
CO3	Design assembly workstation using concepts of simultaneous engineering.
CO4	Design automated fabricated systems – Case studies.

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	1	-	-	-	-	-	-	2
CO2	2	2	3	2	1	2		1	-	-	2
CO3	3	3	3	2	-	-	1	1	-	1	2
CO4	3	3	3	2	-	-	1	-	-	1	2

DETAILED SYLLABUS:

Introduction: Background and challenges faced by modern production environment, sequential engineering process, Concurrent engineering definition and requirement, meaning of concurrent objectives of CE, benefits of CE, Life cycle design of products, life cycle costs.
Strategic approach and technical aspects of product design: Industrial Design, Quality Function deployment, house of quality, Translation process of quality function deployment (QFD**).** Modeling of Concurrent Engineering Design-Compatibility approach, Compatibility index.
Issues in manufacturing systems design: Design for Manufacturing, role of DFM is CE, DFM methods, e.g. value engineering, DFM guidelines, design for assembly, creative design methods, product family themes, design axioms, Taguchi design methods, Computer based approach to DFM. Evaluation of manufacturability and assemblability.
Assembly Workstation Design: Design for Assembly, Design for reliability, life cycle serviceability design, design for maintainability, design for economics, decomposition in concurrent design, concurrent design case studies.
Design of automated fabrication systems: Virtual reality tools and techniques for product development and interactive modeling and visualization, Rapid Prototyping. Design for manufacturing, integrated concurrent design and product development, Case studies, DYNAMO, STELLA and SD based management games.

READING:

1. James L Nevins and Daniel E Whitney, *Concurrent Design of Product and Processes*, McGraw Hill, 1989.
2. Andrew Kusiak, *Concurrent Engineering: Automation, Tools, and Techniques*, Wiley-Interscience, 1992.
3. D. D. Bedworth, M. R. Henderson and P. M. Wolfe, *Computer Integrated Design and Manufacturing*, 1991. McGraw Hill.

ME5366	ARTIFICIAL INTELLIGENCE	DEC	3-0-0	3

PRE REQUISITES: None

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1	Understand problem solving methods, state space problems and search methods.
CO2	Understand knowledge acquisition and representation methods.
CO3	Apply knowledge base system for assembly, process planning and scheduling.
CO4	Develop ANNs and Fuzzy sets for manufacturing systems.

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	1	2					1	1
CO2	2	2	2	1	2					1	1
CO3	1	2	2	1	2	1	1			1	1
CO4	2	2	2	2	3	1	1	1	1		1

DETAILED SYLLABUS:

1. Artificial Intelligence (A.I.): Problem Space, Problem solving, State space, Algorithm's performance and complexity, Search Algorithms, Depth first search method, Breadth first search methods their comparison, A*, AO*, Branch and Bound search techniques, p type, Np complete and Np Hard problems.

2. Knowledge Acquisition and Representation: Manual approach to knowledge Acquisition, Machine Learning approach to Knowledge Acquisition, Semantic nets, Inheritance in Semantic nets, Manipulating monotonic and default inheritance in Semantic nets, Frames, Inheritance in Tangled Frames, Petri nets, Conceptual Dependency, Scripts.

3. Learning Systems: Learning concepts, a simple Learning Algorithm, Nearest Neighbors Algorithm, supervised Learning and unsupervised Learning, Reinforcement Learning, Learning by Inductive Logic Programming, Computational Leaning Theory.

4. Expert systems, Expert system applications for CIM: Introduction to Expert Systems (ES), Personnel Involved in Expert System, Criteria for building an expert system, Architecture of an Expert System, Components of Expert Systems, Inference engines control Strategy, Building an Expert System, Applications in Capacity planning, Facility Location, Inventory Control, Scheduling.

5. Knowledge based systems (KBS): Basic Knowledge based system Architecture, Active Knowledge based systems, Knowledge Development Expert systems, Using Knowledge Distribution in Engineering, A Universal representation Paradigm for Knowledge Base Structuring Methods.

6. Artificial Neural Networks: Neuron, Nerve structure and synapse, Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Back propagation algorithm, factors affecting back propagation training, applications.

7. Fuzzy Logic And Fuzzy Sets: Fuzzy set Theory, Interval arithmetic, Operations on Fuzzy Sets, Fuzzy Logic Theory, Classical Logic Theory, Fuzzy System Modeling, Fuzzy Control Systems, Adaptive fuzzy Control.

8. Applications of Fuzzy Systems and ANNS for selection of Robots: Health Monitoring Fuzzy Diagnostic Systems, Fuzzy Controller for Robotic Manipulator, Fuzzy Control for Servo Mechanic Systems, ANN for Robotic path Planning, Fault detection and isolation in Robotics.

READING:

1. Andrew Kusiak, Intelligent Manufacturing Systems, Prentice Hall Publications.2005
2. Simons, G. L., Introducing Artificial Intelligence, NCC Pub., 1990.
3. Andrew Kusiak, Computational Intelligence in Design and Manufacturing, John Wiley and Sons, 2000.

ME5367	COMPUTER NETWORKS FOR MANUFACTURING	DEC	3-0-0	3

PRE-REQUISITES: ME5301 CNC SYSTEMS AND PROGRAMMING

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1.	Understand the importance of data communications in CIM environment.
CO2.	Understand the concepts in multiplexing.
CO3.	Identify the errors in communications and apply correction strategies.
CO4.	Analyze the role of OSI model in the design of communication protocols.

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	1	-	-	-	1	-	-	-	-
CO2	1	2	1	1	-	-	-	-	-	-	-
CO3	1	1	1	1	-	-	-	-	-	-	-
CO4	1	2	1	-	-	2	2	2	1	1	1

DETAILED SYLLABUS:

Introduction to Data Communications: Data Communications, Networks, The Internet – History, Protocols and Standards. Network Models: Layered Tasks, The OSI model, Layers in the OSI model, TCP/IP Protocol Suite, Addressing.

Physical Layer and Media: Bandwidth Utilization, Multiplexing, Spread Spectrum, Transmission media – guided and unguided.

Data Link Layer: Error Detection and Correction, Data Link Control, Multiple Access, Wired LANs: Ethernet, Wireless LANs.

Network Layer: Network layer: logical addressing and Internet Protocol.

Transport and Application Layer: Process-to-Process Delivery: UDP, TCP and SCTP. Domain Name System, Remote Logging, Electronic Mail, and File Transfer.WWW and HTTP.Crptography.

READING:

1. Behrauz A. Forouzan, Data Communication and Networking, 4th Edition, Tata McGraw Hill Edition.2003.
2. James F. Kurose, Keith W. Ross, Computer Networking - A Top Down Approach Featuring the Internet, Addison-Wesley Longman Pvt. Ltd, 2001.

ME5368	PRODUCT DESIGN FOR MANUFACTURING AND ASSEMBLY	DEC	3-0-0	3

PRE REQUISITES: None

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1	Understand the quality aspects of design for manufacture and assembly.
CO2	Apply Boothroyd method of DFM for product design and assembly.
CO3	Apply the concept of DFM for casting, welding, forming and assembly.
CO4	Identify the design factors and processes as per customer specifications.
CO5	Apply the DFM method for a given product.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	1	1	2	2	1	1	-	1	1	1
CO2	1	1	1	2	2	1	1	1	1	1	1
CO3	2	2	2	2	2	1	-	-	1	1	1
CO4	2	2	2	2	2	2	1	1	1	1	1
CO5	1	2	2	2	2	2	1	1	1	2	1

DETAILED SYLLABUS:

Introduction to DFM, DFMA: How Does DFMA Work?, Reasons for Not Implementing DFMA, What Are the Advantages of Applying DFMA During Product Design?, Typical DFMA Case Studies, Overall Impact of DFMA on Industry.

Design for Manual Assembly: General Design Guidelines for Manual Assembly, Development of the Systematic DFA Methodology, Assembly Efficiency, Effect of Part Symmetry, Thickness, Weight on Handling Time, Effects of Combinations of Factors, Application of the DFA Methodology.

High speed Automatic Assembly & Robot Assembly: Design of Parts for High-Speed Feeding and Orienting, Additional Feeding Difficulties, High-Speed Automatic Insertion, General Rules for Product Design for Automation, Design of Parts for Feeding and Orienting, Product Design for Robot Assembly.

Design for Machining and Injection Molding: Machining Using Single-Point & Multi point cutting tools, Choice of Work Material, Shape of Work Material, Machining Basic Component Shapes, Cost Estimating for Machined Components, Injection Molding Materials, The Molding Cycle, Injection Molding Systems, Molding Machine Size, Molding Cycle Time, Estimation of the Optimum Number of Cavities, Design Guidelines.

Design for Sheet Metal working & Die Casting: Dedicated Dies and Press-working, Press Selection, Turret Press working, Press Brake Operations, Design Rules, The Die Casting Cycle, Auxiliary Equipment for Automation, Determination of the Optimum Number of Cavities, Determination of Appropriate Machine Size, Die Casting Cycle Time Estimation, Die Cost Estimation, Design Principles.

Design for Assembly Automation: Fundamentals of automated assembly systems, System configurations, parts delivery system at workstations, various escapement and placement devices used in automated *as*sembly systems, Quantitative analysis of Assembly systems, Multi station assembly systems, single station assembly lines.

READING:

1. Geoffrey Boothroyd, Assembly Automation and Product Design, Marcel Dekker Inc., NY, 3rd Edition,2010.
2. Geoffrey Boothroyd, Hand Book of Product Design, Marcel Dekker Inc., NY, 1992.

ME5471	FINITE ELEMENT ANALYSIS	DEC	3-0-0	3

PRE-REQUISITES: None

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1	Understand the Finite Element Formulation procedure for structural Problems.
CO2	Understand the representation and assembly considerations for Beam and Fram elements.
CO3	Analyze Plane stress, Plane strain, axi-symmetric Problems.
CO4	Formulate and solve simple heat transfer and fluid mechanics problems
CO5	Identify significant applications of FEM in Manufacturing.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	-	-	2	-	-	-	-	-	1
CO2	2	2	-	-	2	-	-	-	-	-	1
CO3	2	2	-	-	2	-	-	-	-	-	1
CO4	2	2	-	-	2	-	-	-	-	-	1
CO5	2	2	-	-	2	-	-	-	-	-	1

DETAILED SYLLABUS:

Introduction: Historical Perspective of FEM and applicability to mechanical engineering problems.

Mathematical Models and Approximations: Review of elasticity, mathematical models for structural problems, Equilibrium of continuum-Differential formulation, Energy Approach-Integral formulation, Principle of Virtual work - Variational formulation. Overview of approximate methods for the solution of the mathematical models; Ritz, Rayleigh-Ritz and Gelarkin's methods. Philosophy and general process of Finite Element method.
Finite Element Formulation: Concept of discretisation, Interpolation, Formulation of Finite element characteristic matrices and vectors, Compatibility, Assembly and boundary considerations.

Finite element Method in One Dimensional Structural problems: Structural problems with one dimensional geometry. Formulation of stiffness matrix , consistent and lumped load vectors. Boundary conditions and their incorporation: Elimination method, Penalty Method, Introduction to higher order elements and their advantages and disadvantages. Formulation for Truss elements, Case studies with emphasis on boundary conditions and introduction to contact problems.
Beams and Frames: Review of bending of beams, higher order continuity, interpolation for beam elements and formulation of FE characteristics, Plane and space frames and examples problems involving hand calculations.

Two dimensional Problems: Interpolation in two dimensions, natural coordinates, Isoparametric representation, Concept of Jacobian. Finite element formulation for plane stress plane strain and axi-symmetric problems; Triangular and Quadrilateral elements, higher order elements, subparametric, Isoparametric and superparametric elements. General considerations in finite element analysis of two dimension problems.Introduction plate bending elements and shell elements.

Three Dimensional Problems: Finite element formulation for 3-D problems, mesh preparation, tetrahedral and hexahedral elements, case studies.

Dynamic Analysis: FE formulation in dynamic problems in structures using Lagragian Method , Consistent and lumped mass models, Formulation of dynamic equations of motion and introduction to the solution procedures.

FEM in Heat Transfer and Fluid Mechanics problems: Finite element solution for one dimensional heat conduction with convective boundaries. Formulation of element characteristics and simple numerical problems. Finite element applications in one dimensional potential flows; Formulation based on Potential function and stream function.

Algorithmic Approach for problem solving: Algorithmic approach for Finite element formulation of element characteristics, Assembly and incorporation of boundary conditions. Guidelines for code development. Introduction to commercial FE packages.

READING:

1. Seshu P, Textbook of Finite Element Analysis, PHI. 2004
2. Reddy, J.N., Finite Element Method in Engineering, Tata McGraw Hill, 2007.
3. SingiresuS.Rao, Finite element Method in Engineering, 5ed, Elsevier, 2012
4. Zeincowicz, The Finite Element Method for Solid and Structural Mechanics, 4th Edition, Elsevier 2007.

ME 5354	MANUFACTURING SIMULATION LAB	PCC	0-0-3	2

PRE-REQUISITES: None

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1	Design and run simulation experiments using software packages including PROMODEL, LEXSIM, AUTOMOD, AWESIM.
CO2	Model and study a given manufacturing scenario using simulation.
CO3	Analyze the behaviour of manufacturing system using simulation.
CO4	Evaluate and compare different manufacturing control policies using

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	1	1	-	3	-	-	1	1	-	1
CO2	3	3	2	-	3	-	-	1	1	-	1
CO3	3	3	2	-	3	-	-	1	1	-	1
CO4	3	3	2	-	3	-	-	1	1	-	1

LIST OF EXPERIMENTS:

1. Simulation of single line multi stage manufacturing system.
2. Simulation of multi line multi stage manufacturing and assembly system.
3. Simulation of manufacturing systems under variability conditions.
4. Study the effect of variability on performance of typical manufacturing system.
5. Simulation of CONWIP control system.
6. Simulation of KANBAN control system.

ME 5255	CNC LAB	PCC	0-0-3	2

PRE-REQUISITES: None

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1	Develop manual part programs for 2D-complex profiles for Fanuc and Siemens controlle using CNC Simulator and Sinutrain Software.
CO2	Generate CNC program for turning and milling of component using Master CAM and Edg CAM softwares.
CO3	Generate and verify CNC code using Virtual CNC software.
CO4	Machine complex profiles on CNC machine using auto generated CNC code.

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	3	1	2	-	1	-	-	-	1	1
CO2	3	2	1	3	-	1	-	2	1	1	1
CO3	3	2	2	3	-	1	-	2	2	2	2
CO4	3	3	3	3	-	-	-	3	2	3	3

DETAILED SYLLABUS:

Manual Part programming for Fanuc and Simens Controller using CNC Simulator and Sinutrain, CNC programming for turned and milled components using EdgeCAM, Sinutrain and Master CAM, Training on CNC machines.

LIST OF EXPERIMENTS:

1. Simulation of turn components on CNC Simulator.(3-4 Exercises)
2. Turning of components on spinner.com Lathe. (3-4 Exercises)
3. Turning of components on VDF lathe. (3-4 Exercises)
4. Milling simulation of 2D profiles on CNC Simulator. (3-4 Exercises)
5. Milling Simulation of Turbine blade on CNC Simulator.
6. Milling of 2D profiles on Max Mill CNC milling Machine. (2-4 Exercises)
7. Milling of 2D / 3D profiles using Master Cam. (2-4 Exercises)
8. Milling of 2D / 3D profiles using Edge Cam. (2-4 Exercises)
9. Generate and visualize CNC code using Virtual CNC Software. (2-4 Exercises)

READING:

1. NITW CNC Lab Manual,
2. John Stenerson and Kelly Curran, Computer Numerical Control: Operation and Programming, PHI, New Delhi, 2009.
3. TC Chang, RA Wysk and HP Wang, Computer Aided Manufacturing, PHI, New Delhi, 2009.

ME5391	SEMINAR	PCC	0-0-3	2

PRE-REQUISITES: None

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1	Identify and compare technical and practical issues related to the area of cours specialization.
CO2	Outline annotated bibliography of research demonstrating scholarly skills.
CO3	Prepare a well organized report employing elements of technical writing and critica thinking
CO4	Demonstrate the ability to describe, interpret and analyze technical issues and develo competence in presenting.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	1	-	2	-	-	2	-	-	-	2
CO2	2	1	1		-	-	1	-	-	-	2
CO3	3	2	-	1		2	3	-	-	-	1
CO4	1	-	-	2	2	-	-	-	-	-	-

ME6342	**COMPREHENSIVE VIVA – VOCE**	**PCC**	*0-0-0*	**2**

COURSE OUTCOMES:

CO1	Comprehend the knowledge gained in the course work
CO2	Infer principles of working of advanced manufacturing systems and controls
CO3	Acquaint with Computer Integrated Manufacturing Technology and ability in probler solving.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	3	-	-	-	-	-	1	3
CO2	2	1	1	2	-	-	-	-	-	-	2
CO3	1	-	1	1	-	2	-	-	-	-	1

ME6349	**Dissertation Part – A**	**PCC**	*0-0-0*	**8**

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1	Identify a topic in advanced areas of “Manufacturing Engineering”
CO2	Review literature to identify gaps and define objectives & scope of the work
CO3	Employ the ideas from literature and develop research methodology
CO4	Develop a model, experimental set-up and / or computational techniques necessary t meet the objectives.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	3	2	2	-	3	-	-	-	1	2
CO2	2	2	3	-	-	-	-	-	-	1	3
CO3	3	3	2	1	3	1	-	-	-	-	1
CO4	2	2	2	3	3	-	-	-	-	-	-

ME6399	Dissertation Part – B	PCC	*0-0-0*	18

COURSE OUTCOMES: At the end of the course, the student shall be able to:

CO1	Identify methods and materials to carry out experiments/develop code
CO2	Reorganize the procedures with a concern for society, environment and ethics
CO3	Analyze and discuss the results to draw valid conclusions
CO4	Prepare a report as per the recommended format and defend the work.
CO5	Explore the possibility of publishing papers in peer reviewed journals/conferenc proceedings.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	1	3	1	-	-	-	1	2	2
CO2	1	1	-	-	-	-	-	-		1	-
CO3	3	2	-	2	-	-	-	-	1	1	2
CO4	1	2	-	3	2	-	-	-	3	1	1
CO5	2	2	-	2	-	-	-	-	2	-	2