Savitribai Phule Pune University

Faculty of Engineering
Board of Production and Industrial Engineering

Master of Engineering

Syllabus

for

ME Production - CAD / CAM Engineering

Effective from June 2017

M. E. – Production Engineering [CAD/CAM] 2017
Semester I

Course Code	Course	Teaching Scheme (Hrs/week)			Examination Scheme						Credit	
		Theory	Practical	Tutorial	Paper		TW	OR	PR	Total	TH/TW/TUT	PR/OR
					In-Sem	End-Sem						
511101	Mathematics and Statistics	4	-	-	50	50	-	-	-	100	4	-
511102	Research Methodology	4	-	-	50	50	-	-	-	100	4	-
511301	Computer aided design	4	-	-	50	50	-	-	-	100	4	-
511302	Computer aided Manufacturing	4	-	-	50	50	-	-	-	100	4	-
511303	Elective I	5	-	-	50	50	-	-	-	100	5	
511304	Lab Practice I	-	4	-	-	-	50	50	-	100	--	4
Total		**21**	**4**	**-**	**250**	**250**	**50**	**50**		**600**	**21**	**4**

M. E. – Production Engineering [CAD/CAM] 2017
Semester II

Course Code	Course	Teaching Scheme (Hrs/week)			Examination Scheme						Credit	
		Theory	Practical	Tutorial	Paper		TW	OR	PR	Total	TH/TW/TUT	PR/OR
					In-Sem	End-Sem						
511305	Computer Integrated Manufacturing	4	-	-	50	50	-	-	-	100	4	-
511306	Artificial Intelligence & Robotics	4	-	-	50	50	-	-	-	100	4	-
511307	Computation Techniques in CAD/CAM	4	-	-	50	50	-	-	-	100	4	-
511308	Elective II	5	-	-	50	50	-	-	-	100	5	-
511309	Lab Practice II	-	4	-	-	-	50	50	-	100	-	4
511310	Seminar I	-	4	-	-	-	50	50	-	100	--	4
Total		**17**	**8**	**-**	**250**	**250**	**50**	**50**		**600**	**17**	**8**

M. E. – Production Engineering [CAD/CAM] 2017

Semester III

Course Code	Course	Teaching Scheme (Hrs/week)			Examination Scheme						Credit	
		Theory	Practical	Tutorial	Paper		TW	OR	PR	Total	TH/TW/TUT	PR/OR
					In-Sem	End-Sem						
611101	Computational Intelligence in Tool Design	4	-	-	50	50	-	-	-	100	4	-
511311	Computer aided Production planning.	4	-	-	50	50	-	-	-	100	4	-
511312	Elective III	5	-	-	50	50	-	-	-	100	5	-
511313	Seminar II	-	4	-	-	-	50	50	-	100	-	4
511314	Project Work Stage I	-	8	-	-	-	50	50	-	100	-	8
.Total		**13**	**12**	**-**	**150**	**150**	**100**	**100**	**-**	**500**	**13**	**12**

M. E. – Production Engineering [CAD/CAM] 2017

Semester IV

Course Code	Course	Teaching Scheme (Hrs/week)			Examination Scheme						Credit	
		Theory	Practical	Tutorial	Paper		TW	OR	PR	Total	TH/TW/TUT	PR/OR
					In-Sem	End-Sem						
511315	Seminar III	-	5	-	-	-	50	50	-	100		5
511316	Project Work Stage II	-	20	-	-	-	150	50	-	200		20
Total			**25**	**-**	**-**	**-**	**200**	**100**	**-**	**300**		**25**

Elective I

a) Advance Machine Tool Design
b) Quality and Reliability Engineering
c) Intelligence Manufacturing System
d) Mechatronics

Elective II

a) Manufacturing System Design
b) Rapid Prototyping
c) Product Life Cycle Management
d) CAD/CAM/CAE Software Development

Elective III (Open Elective)

a) Tribology and Surface Engineering
b) Energy Resource Management
c) Human Factors in Design & Manufacturing
d) Engineering Economic and Costing

511101: Mathematics and Statistics

Teaching Scheme	Examination Scheme
Lectures: 4 hrs/week	End semester: 50
Credits: 4	In semester: 50

Course Objectives:

- Introduce complex variables, various theorems and applications
- Introduce Calculus of variations and different problems on physical situations and their solutions by various methods
- Define and give concrete ideas about difference equations and their applications
- Introduce series solutions for special functions, Bessel's and Legendre polynomials Fourier Bessel expansion and its application to boundary value problems.
- Introduce new concept of Mathematical modeling, number generation and simulations
- Deal with Statistics and probability, stochastic processes, Markov Process.

Course Outcomes

- Analyze the given complex number, solve various problems on complex variables, apply various theorems of complex variables, and apply series solution method.
- Interpret variation notation, Euler's first order condition, assimilate various principals, equations and variation problems.
- Distinguish differential and difference equations and their solutions, finite difference solutions of types elliptic parabolic and hyperbolic, apply Laplace , Poisson and Cauchy's equations practically in various fields.
- Express differential equation and its solution in Series, & apply the fundamentals concepts of Bessel's functions and Legendre's polynomial, generating functions etc. Apply these for solving boundary value problems.
- Fit models to data, create simulations, Simulate output analysis.
- Analyze random variables, distribution theory, Markov Process and test reliability.

Unit I

Complex Variables

Analytical functions, conformal mapping, bilinear transformations, complex integration, Cauchy's integral theorem and formula, Taylor's and Laurent's series, Cauchy's residue theorem, Applications to Dirichlet's and Neumann's problems.

Unit II

Calculus Of Variations

Introduction, Variational notation, Euler's first order condition with extension to several independent variables, constraints and Lagrange's multipliers, Hamilton's principle, Lagrange's equation in generalized co-ordinates, strum-Liouville's equation with orthogonal character of the solution for different values of physical problems involving differential equations expressed as Variational problems Galerkin's and Raleigh- Ritz method.

Unit III

Numerical Solution to Partial Differential Equations

Difference equations and their types, Solutions of difference equations, finite difference equivalence of solutions of Elliptic Parabolic and hyperbolic equations. Applications to Laplace, Poisson and Cauchy's equations.

Unit IV

Special Functions

Differential Equations and its solutions in series, Bessel's and Legendre's differential equations and their series solutions, properties of Bessel's functions and Legendre's polynomials, generating functions, recurrence relations, Fourier Bessel expansion of function and its applications to boundary value problems.

Unit V

Mathematical Modeling

Proportionality Models, fitting models to data, creating simulations, dimensional analysis, probabilistic modeling, optimization (discrete and continuous models), multivariate random number generation, bootstrapping, Monte Carlo simulation, efficiency improvement techniques, simulation output analysis.

Unit VI

Statistics and Probability

Random variables, various distributions, sampling theory, Chi- square test, t-tests, elementary Stochastic process's, Markov-chain, Markov process, reliability testing. Control chart.

References

1. Erwin Kreyzig, Advanced Engineering Mathematics, Jhon Wiely & Sons. ISBN: 0470458364
2. Spiegel, Complex Variables, Schaum's Series. ISBN: 0070602301
3. B.S. Grewal, Numerical Methods in Engineering and Science, Khanna Publishers, New Delhi.
4. Mark Meerschaert, Mathematical Modeling, Elsevier. ISBN: 0123708575
5. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, New Delhi. ISBN: 8174091955

51102 Research Methodology

Teaching Scheme	Examination Scheme
Lectures: 4 hrs/week	**End semester: 50**
Credits: 4	**In semester: 50**

Course Objectives:

To provide students in depth knowledge about various soft and hard computing tools and techniques so as to enable them:

- To investigate complex problems in manufacturing
- To investigate laws of nature
- To optimize process parameters
- To provide cost effective solutions

Course outcome:

After learning the course, students will be able to:

- Select and apply appropriate methodology to their research problems.
- Organize, conduct and present the research work in most effective manner

Unit I
Introduction
Nature and objectives of research, Methods of Research: historical, descriptive and experimental, research process, research approaches, criteria for good research, problems faced by researchers

Unit II
Research Design
Meaning of research design, need of research design, features of good design, different research designs, basic principles of experimental designs, design of experiments.

Unit III
Data Collection
Types of data, methods and techniques of data collection, primary and secondary data, meta analysis, historical methods, content analysis, devices used in data collection, pilot study and pretest of tools, choice of data collection methods.

Unit IV
Processing and Analysis of Data
Use of statistics for data analysis, measures of central tendency, dispersion, skewness and relationship. Sampling distributions, sampling theory, determination of sample size, chi-square test, analysis of variance, multiple regression analysis, neural networks.

Unit V

Decision Making Techniques

Multi-attribute decision making techniques: Analytical Hierarchy Process (AHP), TOPSIS, Data Envelope Analysis (DEA), graph theory and matrix approach. Multi-objective decision making techniques: Simulated annealing, Genetic algorithms.

Unit VI

Interpretation and Report Writing

Techniques of interpretation, precautions in interpretation, significance of report writing, different steps in report writing, layout of research report, mechanics of writing research report.

References

1. C.R Kothari "Research Methodology" Wishwa Prakashan, ISBN: 8173280363
2. P.G Triphati "Research Methodology" Sultan Chand & Sons, New Delhi.
3. J. W Barnes, "Statistical Analysis for Engineers and Scientists" McGraw Hill, New York. ISBN: 0078396085
4. Ranjit Kumar "Research Methodology" Pearson Education, ISBN: 9788131704967
4. R. V. Rao "Decision making in the manufacturing environment using graph theory and fuzzy multiple attribute decision making" Springer-Verlag, London. ISBN: 1846288193
5. Rao S. S., "Optimization", Wiley Eastern, New Delhi, 1995. ISBN: 0471550345
6. Montgomery D.C., "Design and analysis of experiments", John Wiley & Sons, ISBN: 0470128666.

511301 Computer Aided Design

Teaching Scheme
Lectures: 4 hrs/week
Credits: 4

Examination Scheme
In semester: 50
End semester: 50

Course Objectives:

- To learn basic and advanced features of current CAD software.
- To understand how CAD technology can be leveraged in the design process

Course outcomes:

Upon successful completion of this course, the student will be able to:

- Design a part or assembly of parts using Computer-Aided Design software.
- Use parametric modeling techniques to reflect engineering requirements.
- Apply top-down design principles to model a design.
- Use motion and interference checking to ensure that parts will not interfere throughout their complete range of motion.
- Use CAD software collaboratively when designing on a team.
- Make appropriate selection of CAD functionality to use as tools in the design process. Communicate effectively the geometry and intent of design features.

Unit I
Introduction
Product Life Cycle, Design Process, Application of Computers for Design, Benefits of CAD, Computer configuration for CAD Applications, Grover's Model of Product life Cycle for Selection of CAD/CAM.

Unit II
Configuration of graphics workstations
Fundamentals of 2D graphics, Menu design and Graphical User Interface (GUI), Parametric Programming, Vector representation of geometric entities, Homogeneous coordinate systems, Geometric transformations.

Unit III
Space Curve design
Analytical and Synthetic approaches, parametric equations, modeling of cubic spline, Bezier curve, B-spline curve and NURBS and their manipulation techniques.

Unit IV
Planes and surfaces design
Analytical and Synthetic approaches, parametric equations, modeling of parametric Surfaces, Surfaces- Coons, Bezier, B-spline and NURBS patches, and Surface manipulation techniques.

Unit V
Geometric modeling techniques
Wireframes, B-Rep, CSG and Hybrid modelers, Feature based, Parametric and Variation modeling.

Unit VI
Virtual realism
Computer animation, mechanical assembly and mass property calculations, CAD/CAM integration,

Text/ References:

1. Rogers D. F. and Adams A., Mathematical Elements for Computer Graphics, McGraw Hill Inc, NY, 1989.
2. Faux I. D. and Pratt M. J., Computational Geometry for Design and Manufacture, John Wiley & sons, NY, 1979
3. Mortenson M. E., Geometric Modeling, John Wiley &sons, NY, 1985
4. Choi B.K., Surface Modeling for CAD/CAM, John Wiley & Sons, NY, 1991.
5. Zeid Ibrahim, CAD/CAM theory and practices, McGraw Hill international edition. 2009.

511302 Computer Aided Manufacturing

Teaching Scheme	**Examination Scheme**
Lectures: 4hrs/week	**In semester: 50**
Credits: 4	**End semester: 50**

Course Objectives:

The course examines the area that is commonly referred to as CAM. The general objectives of the course are to enable the students to:

- Understand Computer Aided Manufacturing (CAM) and its strategic role.
- Explore CAM applications in the production.
- Create a computer aided manufacturing (CAM) model and generate the machining codes automatically using the CAM system.
- Integrate the CAD and CAM systems

Course Outcomes:
After learning the course the students should be able to:

- Describe basic concepts of CAM application.
- Prepare CNC programs for manufacturing of different geometries on milling and lathe machines.
- Classify different components using different techniques of group technology.
- Prepare Process planning for different components.
- Apply Robot for preliminary industrial applications like pick and place.

Unit I.
Machine Centre
Principles of Numerical control, Types of CNC Machine Tools, Features of CNC Systems, Direct numerical control (DNC), Elements of CNC viz. Ball screws, rolling guide ways, structure, drives and controls, standard controllers, Manual part programming with APT, Virtual machining. Machining Centers and Interpolators

Unit II
CNC Programming
Types, Manual Part Programming, Canned Cycle, Offset, APT.

Unit III
Allied Machine
CNC **Presses**, CNC-EDM, CNC-WEDM, CNC-CMM, CNC Molding Machines, Automated Welding**.**

Unit IV

Automated Material Handling

Types of Material Handling System, Configuration, Equipments, Elements AGVS, ASRS, Carousal System, Design & Analysis of Material Handling System, Conveyors, Stores& Storage Systems

Unit V

Automated Assembly &Inspection

Automated Assembly Systems, Automated Inspection Principles & Methods, Sectors Automated inspection principles and methods – sectors techniques for automated inspection - techniques for automated inspection – contact and non-contact inspection methods – in processes automated measuring methods – machine vision – optical inspection methods. Automatic identification

Unit VI

Control Techniques

Shop floor control – factory data collection system – Bar code techniques Computer for local area network – the future automated factory – Human workers in future automated factory – The impact on the society, Digital Manufacturing.

REFERENCES:

1. Mikell P. Grover, Automation, Production System and Computer Integrated Manufacturing, Prentice Hall of India Pvt Ltd, 1995.
2. C. Ray Astaihe, Robots of Manufacturing automation, John Wiley and Sons, New York.
3. Jon Stenerson and Kelly Curran "Computer Numerical Control", Prentice-Hall of India Pvt. Ltd. New Delhi, 2008
4. Ibrahim Zeid "CAD/CAM – Theory and Practice" Mc Hill, International edition, 1998
5. P. N. Rao "CAD/Cam principles and operations", Tata McGraw Hill
6. Reference Manuals of FANUC, Siemens, Mazak, etc.
7. Thomas M. Crandell "CNC Machining and Programming, Industrial Press ISBN- 0-8311-3118-7
8. Bedworth, Wolfe and Henderson – "Computer aided design and manufacturing" – McGraw Hill
9. A. Ghosh and Malik – "Manufacturing Science" Affiliated East West Press Pvt. Ltd.
10. Tilak Raj – "CNC Technology and Programming", Dhanpat Rai Publication Company.

511303A: Advance Machine Tool Design (Elective – I)

Teaching Scheme	Examination Scheme
Lectures: 5hrs/week	In semester: 50
Credits: 5	End semester: 50

Course Objectives:

- To understand different types of machine tools.
- To analyze the source of vibration in machine structure.
- To apply ergonomics in machine control.

Course Outcomes:

- Identify functions of various parts of the machine tool.
- Design parts of Machine tool considering functions of each part.
- Testing machine tool form acceptance point of view.

Unit I

Introduction

Introduction to Metal Cutting Machine tools, Kinematics, Basic Principles of Machine tool design, estimation of drive power. Design requirements of machine tools. Design approach for machine tools. Identification and quantification of objectives and constraints in machine tool design.

Unit II

Design of Structural Components

Design of Machine tool spindle and bearings, Design of power Screws – Static deformation of various machine tool structures - thin walled box structures with open and compliant cross sections - correction coefficients - design of beds, columns, tables and supports. Dynamics of cutting forces - tool chatter - design of sideways.

Unit III

Design of Drives

Design considerations of electrical, mechanical and Hydraulic drives in machine tool, stepped and step-less arrangements and systems. Design of control mechanisms - selection of standard components – Dynamic measurement of forces and vibrations in machine tools - Stability against chatter - use of vibration dampers.

Unit IV

Design of CNC Machine Tool

CNC machine - block diagram showing memory, CPO, I/O, post processor, etc. Machining center, Auto tool changers, uses of Composites in machine tool. DNC and Local Area Network, machines

with Adaptive Control. Design of slides with reinforced PTEE, Ball screw all design, methods of calculation of load, Reliability based design. Static and dynamic rigidity and stability analysis.

Unit V

Testing Of Machine Tools

Vibration study of machine tool structures – micro-displacement and error analysis of machine tools with reference to transmission system and positional displacement (stick slip). Acceptance tests and standardization of machine tools- machine tools reconditioning.

Unit VI

Ergonomics Applied To Machine Tool

Concepts of aesthetics and ergonomics applied to machine tools, Latest trends in Machine Tool Design, Introduction to CAD and Finite Element Method used in machine tool design.

References:

1. Mehta N. K.,"Machine Tool design and Numerical Control",Tata McGraw Hill, 1989ISBN: 1259004570
3. Acherkan N., "Machine Tool Design",Vol.3 and 4,MIR Publishers, Moscow ISBN: 0898750474
4. Sen.G. and Bhattacharya, A., "Principles of Machine Tools",Vol.2,NCB.Calcutta, 1973 ISBN: 81-7381-155-5
5. Basu S. K. and Pal D. K., “Design of Machine Tools”, Oxford University Press, 2008 ISBN: 8120417216
6. Rao S. S., “The Finite Element Method in Engineering”, Elsevier Science and Technology Books, 2004, ISBN: 0750678283.

511303B: Quality and Reliability Engineering (Elective – I)

Teaching Scheme	Examination Scheme
Lectures: 5 hrs. /week	**In semester: 50**
Credits: 5	**End semester: 50**

Course Objectives

This subject provides students with

- Principles of reliability, failure rate and its relation to reliability, probability distribution of the time to failure, exponential and weibull distributions, reliability of systems, series and parallel systems, stand by redundancy, systems mean time to failure, mean residual life, reliability in design.
- Failure mode effect analysis, failure tree analysis, reliability testing and analysis, and warranty problems.
- The ability to use statistical tools to characterize the reliability of an item; the working knowledge to determine the reliability of a system and suggest approaches to enhancing system reliability

Course Outcomes:

Upon completion of the subject, students will be able to

- analyze the interference between strength and stress or life data for estimating reliability;
- apply the appropriate methodologies and tools for enhancing the inherent and actual reliability of components and systems, taking into consideration cost aspects;
- Specify life test plans for reliability validation.
- Use knowledge of the techniques of reliability engineering
- apply learned concepts to improving the maintenance, the maintainability, hazard risk and the safety of a plant
- Develop warranty plans for different products
- Be able to carry out a failure mode effect and criticality analysis.
- Analysis of different failures of a component/equipment

Unit I

Quality Engineering

Concepts of Quality Engineering, Taguchi's Approach to Quality, On-line and Off-line Quality Control, Difference from Classical Approach, Quality Loss Function,System Design, Parameter Design, Tolerance Design, Causes of Variation,Classification of Parameters, Parameter Design Strategy

Unit II

Robust Design

Robust design steps, Quality Characteristics and Objective Functions, Control Factors and their Levels, Noise Factors and Testing Conditions, Planning and Conducting the Experiment

Unit III

Response Surface Methodology

First- order and Second-order Models, Crossed Array Experiments, Signal-to-Noise Ratios

Unit IV

Reliability Engineering

The Reliability Function, Failure Rate, Hazard Rate, Bath-tub Curve, Relationship between Various Reliability Characteristics

Component Reliability

Mean-time-to-failure, Time-dependent Hazard Models –Constant-hazard, Linear-hazard, Nonlinear-hazard and Gamma Models

Unit V

System Reliability

Two-state Modeling, Series Models, Parallel Models, Series-parallel and Parallel-series Models, k-out-of-m Models, Standby Models, Non-series-parallel Models, Fault-tree Approach to System Modeling

Unit VI

Maintained Systems

Classification of Maintenance Activities: Breakdown, Preventive and Predictive Maintenance, Condition Monitoring, Maintainability and Availability, Reliability-centered Maintenance

Reference Books

1. Phadke, M (1989). Quality Engineering using Robust Design, Prentice Hall.
2. Ross, P (1996). Taguchi Techniques for Quality Engineering, 2nd edition, McGrawHill.
3. Balgurusamy E (2003). Reliability Engineering, Tata McGraw Hill.
4. Birolini A (2004). Reliability Engineering: Theory and Practice, 4th edition, Springer.
5. Crowder M, Kimber A, Smith R and Sweeting T (1991). Statistical Analysis ofReliability Data, Chapman and Hall.
6. Kumamoto H and Henley E (1996). Probabilistic Risk Assessment and Managementfor Engineers and Scientists, IEEE Press.

511303C: Intelligence Manufacturing System (Elective – I)

Teaching Scheme	Examination Scheme
Lectures: 5 hrs/week	**In semester: 50**
Credits: 5	**End semester: 50**

Course Objectives:

To provide students in depth knowledge through practical case studies related to artificial intelligence (AI) and decision making techniques to solve the real problems in automated manufacturing system. The objective of this course is to learn the statistics and optimization methodologies in intelligent manufacturing systems. The students will know how to apply.

Course Outcome:

Student will be able to apply the intelligent systems such as Evolutionary computation, fuzzy logic, Bayesian network, Hidden Markov model, Kalman filter, Decision theory and Utility theory, statistical learning methods, support vector machines, neural networks, expert systems etc in various applications in manufacturing such as:

- Process planning
- Process optimization
- Cellular manufacturing
- Route optimization of AS/RS
- Robot path palling etc.

Unit I:
Introduction to artificial intelligent techniques [7]
Goals of AI in manufacturing, tools for AI such as Search algorithm, Mathematical optimization, Evolutionary computation, fuzzy logic, Probabilistic methods for uncertain reasoning such as Bayesian network, Hidden Markov model, Kalman filter, Decision theory and Utility theory, statistical learning methods, support vector machines, neural networks, expert systems.

Unit II:
Industrial planning and decision making using intelligent systems [7]
Production planning using fuzzy cognitive maps, computer aided process planning, Methods for inventory space allocation and storage processes analysis, Optimization of production costs and methods finding of the best process plan, Methods for production equipment selection and layout, Heuristic scheduling of multiple resources, Fuzzy multiple attribute decision making methods.

Unit III:
Intelligent techniques for manufacturing process optimization [7]
Application of neural networks and fuzzy sets to machining and metal forming, Artificial neural network modeling of surface quality characteristics in machining processes, parametric optimization of machining processes using evolutionary optimization methods**.**

Unit IV:

Knowledge Based Group Technology [7]

Group Technology: Models and Algorithms – Visual method, Coding method, Cluster analysis Method Knowledge based group technology – Group technology in automated manufacturing system, Structure of knowledge based system for group technology (KBSGT) –database, knowledge base, and Clustering algorithms

Unit V:

Intelligent robotic systems [7]

Applications of intelligent systems for mobile Robot Motion Planning, Path Planning Robot Control in Dynamic Environments, Task Based Hybrid Closure Grasping Optimization for Autonomous Robot Hand. Accurate Motion Control of Fast Mobile Robots, obstacle avoidance. B. E. [Production Engineering] Syllabi 2012 Course

Unit VI:

Use of intelligent techniques in flexible manufacturing systems (FMS) [7]

Applications of various intelligent systems for FMS functional segmentation schemes including control, real time scheduling, tool management, process planning, route optimization for AS/RS systems.

References:

1. Andrew Kussiak, “Intelligent Manufacturing Systems”, Prentice Hall , 1990

2. Badiru A.B., “Expert Systems Applications in Engineering and Manufacturing”, Prentice-Hall, New Jersey, 1992.

3. Liu, Dikai, Wang, Lingfeng, Tan, Kay Chen (Eds.) Design and Control of Intelligent Robotic Systems, Springer-Verlag, London. ISBN 978-3-540-89932-7

4. Rao R. V. “Advanced Modeling and Optimization of Manufacturing Processes”, Springer-verlag, London. ISBN 978-0-85729-014-4

511303D: Mechatronics (Elective - I)

Teaching Scheme	Examination Scheme
Lectures: 5 hrs/week	**In semester: 50**
Credits: 5	**End semester: 50**

Course objectives:

- Develop an understanding of the basic elements underlying mechatronic systems:.
- Understand how to interface electromechanical systems to microcontrollers.
- Developing understanding of Process Control Computer Systems.
- Gain hands-on experience with commonly used electronic test and measurement instrumentation.

Course Outcomes:

The Student will be able to –

- Define the Mechatronics systems, measurement and control system.
- Understanding various sensors and transducers and their applications.
- Describe the architecture, configuration and interfacing of Microprocessor.
- Understand the Mini, Micro Computer process and Digital processes.
- Analyze the logic of Programmable logic controllers and state their applications.
- Illustrate the advanced applications in Mechatronics.

Unit I

Introduction

Introduction to mechatronics system, evolution, scope and components of mechatronics systems, mechatronics in product and measurement system, control system and modes of control, traditional design and mechatronics design

Unit II

Actuators, Sensors and Transducers

Hydraulic, pneumatic and electrical actuators and their system modeling, performance terminology, system modeling of sensors; displacement, position and proximity sensors, velocity and acceleration sensors, flow sensors, force sensors, temperature sensors, ultrasonic and fibre-optic sensors, selection of sensor, piezo- electric sensors.

Unit III

Hardware Components

Number systems in Mechatronics, binary logic, Karnaugh map minimization, transducer signal conditioning process, principals of analogue and digital signal conditioning, protection, filtering,

operational and instrumentation amplifiers and their gains, analogue to digital and digital to analogue conversion, multiplexers, pulse modulation.

Unit IV

Programmable Logic Controller

Review of logic gates, basic structure, features, input/output processing, programming, functional block diagram (FBD), ladder diagram, logic functions, latching, sequencing, jumps, internal relays, counters, shift registers, master and jump control, data handling, data movement, data comparison, arithmetic operations, code conversion, analog input and output, applications for automation, diagnostics and condition monitoring.

Unit V

Microcontroller

Comparison between microprocessor and microcontroller, organization of microcontroller system, architecture of MCS 51 controller, pin diagram of 8051, addressing modes, programming of 8051, interfacing input and output devices, interfacing D/A converters and A/D converters, Various applications for automation and control purpose.

Unit VI

Advanced Applications in Mechatronics

Elements of Data Acquisition and Control System, Overview of I/O Process, Installation of the I/O Card and Software, Installation of the application Software, Examples, Over framing. Mechatronic control in automated manufacturing, Artificial Intelligence in mechatronics, Fuzzy Logic application, Microsensors, Case studies of Mechatronics systems.

Reference Books:

1. W. Bolton,Mechatronics 3/e ,Pearson Education
2. Dan Necsulescu, Mechatronics, Pearson Education
3. Kenneth J. Ayala, The 8051 Microcontroller: Architecture, Programming and Applications, 2/e, Penram International
4. N.P.Mahalik, Mechatronics: Principles, Concepts and Applications, TMH
5. David G. Alciatore& Michael B. Histand, Introduction to Mechatronics & Measurement Systems, TMH
6. Critis D. Johnson, Process Control & Instrumentation Technology, Pearson Education
7. Devdas Shetty, Richard A. Kolk, Mechatronics System Design,Thomson
8. YoramKoren, Computer Control of Manufacturing Systems, McGraw Hill
9. S. Brain Morriss, Automated Manufacturing Systems: Sensors, Actuators, McGraw Hill
10. David W. Pessen, Industrial Automation, John Wiley & Sons
11. Richard L. Shell & Ernest L. Hall, Handbook of Industrial Automation, Marcel Decker Inc.
12. Jack R. Hackworth & Fredrick D. Hackworth,Jr., Programmable Logic Controllers" Programming Methods and Applications (with CD Rom), Pearson Education

511304 Lab Practice I

Teaching Scheme	Examination Scheme
Practical: 4 hrs/week	**Oral: 50 Marks**
Credits: 4	**TW: 50 Marks**

Each student should write at least two assignments on each theory subject studied in Semester I and conduct minimum Six experiments from the list given below as laboratory work.

1. 2D drawing and drafting using sketcher workbench – 2 drawings
2. 3D modeling and drafting using 3D features – 5 models
3. Assembling and drafting of 2 assemblies with interference checking.
4. Surface modeling – 4 exercises
5. CNC Lathe – 4 exercises
6. CNC Milling – 4 exercises
   Generation of tool path, generation of NC code, Optimization of tool path
   (to reduce machining time) using any CAM software
7. Robot programming for any two industrial application.(e.g. pick and place, welding, painting etc.)
8. Minimum three programs on PLC for system automation involving of interfacing of sensors and actuators
9. Exercises on a total Mechatronics System Design for applications like packaging, loading/unloading, pick and place etc.

511305 Computer Integrated manufacturing

Teaching Scheme	Examination Scheme
Lectures: 4 hrs/week	**In semester: 50**
Credits: 4	**End semester: 50**

Course objectives-

To use computers in the area of manufacturing to reduce manual processing and linking computers to all the manufacturing machines and increase the productivity, reduce the unnecessary costs. To study about group technology, computer aided process planning, material requirement planning (MRP) Enterprise resource planning (ERP), Computer aided quality control and Flexible manufacturing systems.

Course outcomes

On completion of the course, student will be able to:

- Understand the basic concept of CIM and develop product through CIM.
- Apply various techniques of cellular manufacturing for machine cell formation.
- Learn the different components of Flexible Manufacturing System.
- Understand the principle of networking and design activities in a networked environment.

Unit I
Concept of CIM
Introduction to CIM, Types of Manufacturing, CIM hardware and software, Elements of CIM, Product development through CIM

Unit II
CIM database
Introduction, Database requirements of CIM, Database, Database management, Database Models, Product Data Management (PDM), Advantage of PDM.

Unit III
Work Cell
Define work cell, work cell design and micro layouts, Work cell and Lean manufacturing, Ergonomic considerations, manufacturing work cell optimization

Unit IV
Flexible Manufacturing System
Introduction to FMS, Manufacturing integration model, flexible manufacturing strategy, Components of Flexible Manufacturing-Pallets and fixtures, machining centers, inspection equipment, material handling stations, storage system, In-process storage, manually operated stations, allied operation centers, FMS system design

Unit V

Robots in CIM

Integration of the industrial robot into CIM system, product design of automatic manufacture of robots, computer aided inspection using robots.

Unit VI

Networking in CIM

Principles of networking, Network Techniques, Local area network (LAN), networking standards, Design Activities in a networked environment, networking in a manufacturing company, hardware elements of networking, Collaboration Engineering.

References Book:

1. Paul G. Ranky, The design and operation of FMS, I.F.S. Publi 1983 Harrington J, C.I.M. m Krieger 1979
2. Richard shover, An analysis of CAD/ CAM Application with introduction to C.I.M.
3. Prentice hall inc.Engelwood Cliffs NJ David Bedworth et.al Computer integrated design and manufacturing McGraw hill 1991
4. Scolz B. Reiter C.I.M interfaces Chapman & Hall 1992 David L. Goetsch, fundamental of CIM technology, Delmer Publication 1988

511306 Artificial Intelligence & Robotics

Teaching Scheme	Examination Scheme
Lectures: 4 hrs/week	**In semester: 50**
Credits: 4	**End semester: 50**

Objectives:

- To study robot control systems, sensors & end effector,
- To develop the ability to analyze and design the motion for robotic systems
- To develop ability for robot programming
- To impart basic knowledge of artificial intelligent tools, search strategies, knowledge representation and their applications to robotics

Outcomes:

Students will be able to:

- Design evaluate performance of robotic control system
- Able to use robot programming languages for robot programming
- Able to select and use appropriate sensors and end effectors for given robotics application
- Apply artificial intelligent tools, search strategies, knowledge representation to various robotics applications.

Unit I
Fundamentals of Industrial Robots
Specifications and Characteristics, Basic components, configurations, Criteria for selection, various industrial applications. **Robotic Control Systems:** Drives, Robot Motions, Actuators, Power transmission systems; Robot controllers, Dynamic properties of robots- stability, control resolution, spatial resolution, accuracy, repeatability, compliance.

Unit II
Robotic End Effectors and Sensors
Transducers and sensors- sensors in robotics and their classification, Touch (Tactile) sensors, proximity and range sensors, force and torque sensing, End Effectors- Types, grippers, Various process tools as end effectors; Robot-End effectors interface, Active and passive compliance, Gripper selection and design.

Unit III
Robot Programming
Lead through method, Robot program as a path in space, Methods of defining positions in space, Motion interpolation, branching; Textual robot programming languages

Unit IV
Artificial Intelligence
Concept of A.I., Approaches, Foundations of A.I., Problem Formulation**:** Problem solving agents, Components of problem definition, defining the problem as state space approach, Problem characteristics, Production System, searching for solutions, Forward and backward reasoning, means end analysis, Graphs and trees, measuring problem solving performance

Unit V

Search Strategies

a)Uninformed (blind) search- breadth first, depth first, and their variations, avoiding repeated states; b) Informed (heuristic) search- heuristic function, Generate and test, Best first search, A* search, Local search algorithms- Hill climbing, Simulated annealing, Branch and bound and Local beam search

Unit VI

Knowledge Representation

Simple rational knowledge, Inheritable knowledge, Inferential knowledge, Procedural knowledge, the Frame problem, Propositional logic- Syntax and semantics, well-formed formulas (WFF), conversion to clausal form, using FOPL, inference rules, unification, non-deductive inference methods, resolution, forward and backward chaining, the knowledge engineering process, Handling uncertain knowledge, probability propositions.

Reference Books:

1. Groover, M.P., (2004), "Automation, Production Systems & Computer IntegratedManufacturing" 2/e, (Pearson Edu.) ISBN: 81-7808-511-9

2. Morris, S.Brian (1994), "Automated Manufacturing Systems", (McGraw Hill) ISBN: 0-07-113999-0

3. Pessen, David W.(1990), "Industrial Automation, Circuit Design & Components",(John Wiley & Sons, Singapore)

4. Groover, M.P.; Weiss, M.; Nagel, R.N. &Odrey, N.G. "Industrial Robotics,Technology, Programming & Applications", (McGraw Hill Intl. Ed.) ISBN:0-07-024989-X

5. Fu, K.S.; Gonzalez, R.C. & Lee, C.S.G. "Robotics-Control, Sensing, Vision andIntelligence", (McGraw Hill Intl. Ed.) ISBN:0-07-100421-1

6. Keramas, James G. (1998), " Robot Technology Fundamentals",(Thomson Learning-Delmar) ISBN: 981-240-621-2

1. Noff, Shimon Y. "Handbook of Robotics", (John Wiley & Sons)

2. Niku, Saeed B. (2002), "Introduction to Robotics, Analysis, Systems & Applications" ,(Prentice Hall of India)

3. Koren, Yoram "Robotics for Engineers", (McGraw Hill)

4. Schilling, Robert J.(2004), "Fundamentals of Robotics, Analysis & Control", (Prentice Hall of India), ISBN: 81-203-1047-0

5. Stuart Russel, Peter Norwig (2003), "Artificial Intelligence : A Modern Approach" 2/e, (Pearson Education)

6. Elaine Rich, Kevin Knight, (1991), "Artificial Intelligence" 2/e, (Tata McGraw Hill)

7. Dan W. Patterson (1999), "Introduction to Artificial Intelligence and Expert Systems" (7th Indian Reprint) (EEE) (Prentice Hall of India)

8. Rex Mauss, Jessica Keyes , "Handbook of Expert Systems in Manufacturing", (McGraw Hill)

9. Groover, Weiss, Nagel, Audrey, "Industrial Robotics- Technology, Programming and Applications", (McGraw Hill)

10. Conference Proceedings and current journals for case studies and applications.

511307 Computational Techniques in CAD/CAM

Teaching Scheme	Examination Scheme
Lectures: 4 hrs/week	**In semester: 50**
Credits: 4	**End semester: 50**

Course objective:

- To develop the skills needed to apply Finite Element Methods to problems in Mechanical Engineering.
- To impart the knowledge of governing equations for fluid flow and different turbulence models.
- To learn about the numerical methods used to solve the partial differential equation.
- To solve the fluid flow problem using CFD tool.
- The main objective of this course is to provide the detailed classification of optimization techniques available in order to address wide range of optimization problems.
- The course will also highlight different solution strategies and performance criterion for applied optimization problems.
- Through this course, the students will learn how to formulate an engineering optimization problem.
- The course will also introduce the basics of evolutionary optimization techniques as compared to classical optimization techniques.

Course Outcomes:

The students will be able to

- Apply the procedure involved to solve a structural problem using Finite Element Methods.
- Analyze a 2D and 3D problems using various elements.
- Acquire the knowledge of various types of fluid flow governing equations.
- Analyze the internal fluid flow phenomena of thermal and fluid system.
- Acquire enough knowledge to design of the engineering systems using commercial computational code.
- Design the thermal system using CFD.
- Solve one-dimensional and multi-dimensional engineering optimization problems.
- Analyze the progress of any engineering process in terms of achieving local optimum and global optimum.

Unit I
Finite Element Analysis:

Introduction, Element types and characteristics, Assembly of elements and matrices, Co-ordinate system, Static analysis, Dynamic analysis.

Unit II
Advanced stress analysis:

Component of stress and strain, their principle values and invariant, Complex variable approach, Experimental methods of stress analysis, Introduction to fatigue and fracture mechanics, Linear elastic fracture mechanics (LEFM), Fatigue and fracture safe designs.

Unit III

Computational Fluid Dynamics:

Introduction, Numerical Discretization methods, Basic Equations of Fluid Dynamics, Numerical methods for Convection, Numerical Methods for Inviscid Flows, Numerical methods for Incompressible flows, Turbulence Models.

Unit IV

Advanced numerical methods and their applications

Methods for solving nonlinear equations: Initial value problems and two value boundary problems.Method for solving linear systems: Jacobi, Gauss-Seidel, Conjugate Gradient, multilevel preconditioners and solvers; Ordinary differential equations: forward Euler method, Runge-Kutta method, Stormer-Verlet method;

Unit V

Traditional optimization techniques

Introduction; single variable optimization algorithms – Bracketing methods, region elimination methods, point elimination methods; multivariable optimization algorithms – Direct search methods, Gradient based methods, Constrained optimization algorithms; specialized algorithms Integer programming, geometric programming.

Unit VI

Non-traditional optimization techniques

Genetic algorithms, Simulated annealing, Global optimization using steepest descent method, genetic algorithms, simulated annealing.

References Books :

1. Trupathi R Chandrupatla and Ashook D. Belegundu, Introduction of Finite Element in Engineering, Prentice Hall of India, 1997.
2. Rao S. S., The Finite Element Methods of Engineering, Pergamon Press, 1989.
3. Reddy J. N., An Introduction to Finite Element Methods, Mc Graw Hill Company, 1984.
4. S.P. Thimoshenko and J.N. Goodier, Theory of Elasticity, McGraw-Hill, 1982
5. J. W. Dally and W. F. Riely, Experimental stress analysis, McGraw-Hill, 1978
6. Veersteeg and Malalasekara, CFD: The Finite Volume Method, Prentice Hall, 1996
7. Anderson, Tannehill and Pletcher, Computational Fluid Mechanics and Heat Transfer, Hemisphere Publishers, 1984.
8. C A J Fletcher, Computational Methods for Fluid dynamics: Vol 1 and 2.Springer Verlag, 1987
9. C. Hirsch, Numerical Computation of Internal and External Flows Vol.1 and 2.
10. D C Wilcox, Turbulence Modeling for CFD, DCW Industries.
11. Bose,T.K.,"Numerical Fluid Dynamics" Narosa Publishing House, 1997.
12. Kalyanmoy Deb, “Optimization for Engineering Design”, Prentice Hall of India, New Delhi, 2004
13. Singiresu S. Rao, “Engineering Optimization – Theory and Practice”, Wiley India Pvt Ltd, New Delhi, Fourth Edition, 2014
14. Dennis J Jr, Schnabel R (1996). Numerical Methods for Unconstrained Optimization and Nonlinear Equations, Society for Industrial and Applied Mathematics.
15. Ravindran A, Ragsdell K and Reklaitis G (2006). Engineering Optimization: Methods and Applications, 2nd edition, John Wiley and Sons Inc.

511308A: Manufacturing Systems Design (Elective II)

Teaching Scheme	Examination Scheme
Lectures: 5hrs. /week	In Semester: 50
Credits: 5	End Semester: 50

Course objectives:

- To understand the concept of manufacturing system along with modes of production.
- To establish understanding the concept of product life cycle and computer aided processes planning.
- To acquire the knowledge of information system and its role in manufacturing.
- To understand the computer simulation and modern approaches in manufacturing system.

Course outcomes:

On successful completion of the course students should be able to:

- Understand the modes of production and the system types in manufacturing environment.
- Implement concept of concurrent engineering, computer aided processes planning, Dynamics programming and network techniques in Industry.
- Develop basic mathematical models along with the understanding of industrial cost estimation practice and the optimization of single stage manufacturing.
- Apply modern approaches such as lean production, group technology, cellular manufacturing and flexible manufacturing systems in the industry.

Unit I
Fundamentals
System concept, Hierarchical structure, System design, Decision making procedure, System types in manufacturing environments; Manufacturing Systems: Structural aspects, transformational aspects, procedural aspects, integrated manufacturing systems; Modes of Production- Jobbing / Intermittent /Continuous; Mass Production- Economies of Scale, Optimum production scale, Mass Customization; Multi-Product Small Batch Production- Economies of Scope with Diversification; Logistic Systems- Material flow: conversion / transportation / storage

Unit II
Product / Process Planning and Design
Product Life Cycle, Planning of a new product, Product Design Aspects, Design cost considerations, Concurrent Engineering; Process and Operation Design- Computer Aided Process Planning, Optimum routing analysis using Dynamic Programming and Network Techniques, Criteria for line balancing.

Unit III
Manufacturing Optimization
Criteria for Evaluation, Optimization of single stage manufacturing- Unit production time and cost; Optimization of multistage manufacturing system- Scope, basic mathematical models;

Cost Estimating- Classical metal cutting cost analysis, Industrial cost estimation practices, Estimating material, setup and cycle times.

Unit IV

Information Systems in Manufacturing

Database structures, hierarchical, network, Relational- concepts, keys, relational operations, query languages; Shop Floor Data Collection Systems- Types of data, on-line and off-line data collection, Automatic data collection systems.

Unit V

Computer Simulation in Manufacturing System Analysis

Characteristics, Simulation Models, applications of probability and statistics; Design and evaluation methodology of manufacturing systems, General design framework, Analysis of situation, Setting objectives, Conceptual modeling, Detailed design, Evaluation and Decision.

Unit VI

Modern approaches in Manufacturing

Cellular Manufacturing- Group Technology, Composite part, Rank Order Clustering Technique, Hollier method for GT cell layouts; Flexible Manufacturing- Concept, components, architecture; Lean Production- concept, principles, Agile Manufacturing- concept, principles and considerations for achieving agility.

Reference Books:

1. KatsudoHitomi, (1998), "Manufacturing Systems Engineering", Viva Low Priced Student Edition, ISBN 81-85617-88-0
2. B. Wu, "Manufacturing Systems Design & Analysis: Context and Techniques" (2/e), Chapman & Hall, UK, ISBN 041258140X
3. Mikell P. Groover, (2002), "Automation, Production Systems and Computer Integrated Manufacturing", (2/e), Pearson Education, ISBN 81-7808-511-9
4. Radhakrishan P., Subramaniyan S. and Raju V., "CAD / CAM / CIM", (3/E), New Age International Publication
5. Luca G. Sartori,(1998), " Manufacturing Information Systems", Addison Wesley Publishing Co.
6. N. Viswanadhan & Y, Narhari, (1998), "Performance Modeling of Automated Manufacturing Systems", Prentice Hall of India
7. Phillip F. Ostwald, Jairo Munez, (2002), " Manufacturing Processes and Systems", John Wiley & Sons (Students' Edition), ISBN 9971-512-34-3
8. Sanjay B. Joshi, Jeffrey S. Smith ,(1994), "Computer Control of Flexible Manufacturing Systems: Research and Development", Springer, ISBN 0412562006, 9780412562006

511308B: Rapid Prototyping (Elective II)

Teaching Scheme	Examination Scheme
Lectures: 5 hrs. /week	**In semester: 50**
Credits: 5	**End semester: 50**

Course Objectives:

- To know the principle methods, areas of usage, possibilities and limitations as well as environmental effects of the Additive Manufacturing technologies
- To be familiar with the characteristics of the different materials those are used in Additive Manufacturing.

Course Outcomes:

Upon completion of this course, the students can able to compare different method and discuss the effects of the Additive Manufacturing technologies and analyses the characteristics of the different materials in Additive Manufacturing

Unit I
Introduction to RP
Technology Description and Definition to RP, Overview of RP, Benefits and Application. RP Processes: Process overviews, STL file Generation, File Verification and Repair, Build File Creation, Part Construction, Part Cleaning and finishing, Process Strength and its limitations.

Unit II
Classes of RP systems
3D Printers, Enterprise Prototyping centers, Direct digital tooling, Direct digital manufacturing, system classification, Stereo lithography, SL with photo polymerization, SL with liquid thermal polymerization, Selective Laser Sintering, Fused deposition modeling, Laminated object manufacturing, Laser powder forming

Unit III
Prototype properties
Material properties, color, dimensional accuracy, stability, surface finish, machinability, environmental resistance, operational properties

Unit IV
RP Applications
Design, Concept Models, Form & fit checking, Ergonomic Studies, Functional testing, Requesting Price quotes, CAD data verification, Rapid Tooling, Rapid manufacturing, Science & Medicine, Archeology, Paleontology & forensic Science, miniaturization

Unit V
Fundamental Process
Background, the line spread function of scanned Gaussian Laser Beam. The Parabolic Cylinder, The working curved equation, the curved linewidth function, Mechanical properties,

and bilateral exposure of a Thin Sample, The Photomodulus Model, Experimental Method, and Experimental Results.

Unit VI

Alternate Approach to RP and Manufacturing

Introduction, Laser – Additive Laser Point-by- Point Method, Laser –Additive Non Laser Point-by Point Fabrication, Laser Subtractive Laser Fabrication, Laser Additive Non Laser Fabrication.

References:

1. T. A. Grimm & Associates, Users Guide to Rapid Prototyping, Society of Manufacturing Engineers (SME) ISBN 0872636976
2. Frank W. Liou, Rapid Prototyping & engineering applications, CRC Press, ISBN 978-0-8493-3409-2
3. Rapid Prototyping theory & practice, Manufacturing System Engineering Series, Ali K. Kamarani, Springer Verlag
4. Rapid Prototyping- case book, J. A. McDonalds, C. J. Ryall, Wiley Eastern
5. Rapid & Virtual Prototyping & applications, C. E. Bocking, AEW Rennie, Wiley Eastern
6. Paul F. Jacobs, Rapid Prototyping and Manufacturing, First Edition Published by Society of Manufacturing Engineers. ISBN: 0-87263-425-6

511308C: Product Life Cycle Management (Elective II)

Teaching Scheme	Examination Scheme
Lectures: 5 hrs. /week	In-semester: 50
Credits: 5	End semester: 50

Course objectives:

- To study design aspects of product manufactured by different manufacturing process.
- To study the process of transformation of customer requirements into desirable products.

Course outcomes:

Student will able to design consumer and industrial product using various approaches of product design; and decide the marketing strategies required for different phases of product life cycles.

Unit I
Introduction to PLM
Need for PLM, opportunities and benefits of PLM, different views of PLM, components

of PLM, phases of PLM, PLM feasibility study, PLM visioning.

PLM Strategies: Industrial strategies, strategy elements, its identification, selection and implementation, make – to - stock, assemble-to order, make- to order strategy, change management for PLM, Strategies for recovery at end of life, recycling.

Product Data Management (PDM): PDM systems and importance, reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation.

Unit II
Product Design
Engineering design, Industrial design, Generic product design process, Types of products, Product planning, Identify customer needs, product specifications, concept generation, concept selection, concept testing, prototyping, and product cost analysis.

Unit III
Approaches for Product Design
Mass customization, Kano model, Kansei engineering, conjoint analysis, Product architecture, Modular product architecture, product line design, product configuration, and concurrent engineering.

Unit IV
New Product Development
Structuring new product development, need and importance of NPD Voice of customers(VoC), Methods of VoCs, Quality function deployment, building decision support system, Estimating market opportunities for new product, new product financial control, implementing new product development, product family, product mix, market entry decision, Market segmentation, launching and tracking new product program, concept of redesign of product, product development economics.

Unit V

Design for 'X'

Design for manufacturing, Design for assembly, design for reliability, design for serviceability(maintainability),design for environment, design for safety, design for aesthetics, design guidelines for various casting process, injection molding, turning ,milling grinding, sheet metal working processes.

Unit VI

Technology Forecasting

Future mapping, S-curve, invocating rates of technological change, methods of technology forecasting such as relevance trees, morphological methods and mission flow diagram, product design and process selection, product system-level design, product cannibalization and petrification, use of academic research in product design, combining forecast of different technologies, human factors in product design, modeling and simulation in product design.

References

1. K.T. Ulrich and S.D. Eppinger, Product design and development, Tata McGraw - Hill publishing, New Delhi, 2003, ISBN:007-247146-8
2. Dieter and Schmidt, Engineering Design, McGraw – Hill Higher education, ISBN: 978–0–07–283703–2
3. Saaksvuori Antii "Product life cycle Management", Dreamtech Press, ISBN: 8184892705

511308D: CAD/CAM/CAE Software Development (Elective II)

Teaching Scheme	Examination Scheme
Lectures: 5 hrs. /week	**In semester: 50**
Credits: 5	**End semester: 50**

Course objective:

To impart students with the necessary skills for drafting and modeling machine components using CAD tools

Course Outcomes (COs)

Upon completion of the course, students shall be able to:

- Practice ISO and BIS standards for drafting
- Model and assemble machine parts
- Generate 2D-drawings from 3D models
- Know about the industrial models and their usages in practical design and manufacturing fields.

Unit I
Introduction to Customization
Customization, Application Programming Interface (API), macros, scripts.

Unit II
Tools for Customization
Object Oriented Programming (OOP), OLE interfaces in CAD/CAM software, Use of general programming interfaces like VB, VBS, VC++, OpenGL programming

Unit III
System dependent programming interfaces
Visual LISP (AutoCAD), GRIP (Unigraphics), Pro-Programming (Pro-Engineer), CATIA etc.

Unit IV
Computer-based System Engineering
System engineering process, Software product development life cycle, software processes, software development project management, software prototyping

Unit V
Rapid Development
Core issues in rapid development, rapid development languages, life cycle planning and customer oriented development Solid Modeling Algorithms: Euler operations, basic solid modeling algorithms

Unit VI
Automated Solid Modeling using Customization
Creating 2D, 3D and solid entities through API, Editing 2D, 3D and solid entities through API, Design and development of user interfaces- icons, menus, dialog boxes, integrating databases with CAD, creating bill of material or parts list, automated assembly modeling through customization,

automated drafting and dimensioning using customization, creating automated animations using API and animation software.

Reference Books:

1. Steve McConnel, Rapid Development, Microsoft Press
2. Ian Sommerville, Software Engineering, Pearson Education
3. Foley, Van Dam, et al, Computer Graphics, Pearson Education
4. Mason Woo et al, Open GL Programming Guide
5. George Omura, Advanced AutoCAD
6. Shyam Tickoo, Customizing AutoCAD, Thomson Learning
7. Shyam Tickoo, CATIA, Thomson Learning
8. Martti Mantilya, Solid Modelling, Computer Science Press

511309 Lab Practice II

Teaching Scheme	Examination Scheme
Practical's: 4 hrs. /week	**TW: 50**
Credits: 4	**Oral: 50**

Each student should write at least two assignments on each theory subject studied in Semester II and conduct **minimum six experiments** listed below as laboratory work.

1. Structural Analysis
2. Thermal Analysis
3. Fluid Flow Analysis
4. Coupled Field Analysis
5. Nodal Analysis
    - Minimum four problems shall be solved with hand calculations.
6. Simulation of any manufacturing system and its analysis using any manufacturing simulation package like Witness, Promodel, Arena etc.
7. Co-ordinate Measuring Machine: Case study: Inspection of a component using different probes, generation of report and interface (for example – Gears, Housings, Flywheels, Walls of machine structure, etc.)
8. Solution of constrained and unconstrained non-linear optimization problem using any computer software packages.
9. Development of manufacturing data knowledgebase using any programming language.

511310 Seminar I

Teaching Scheme	Examination Scheme
Practicals: 4 hrs. /week	**Term work: 50 Marks**
Credits: 4	**Oral: 50 Marks**

Each student is required to deliver a Seminar on state of the art topic of his/her choice relevant to any area of CAD/CAM/CAE and submit it in the form of short report.

611101 Computational Intelligence in Tool Design

Teaching Scheme	Examination Scheme
Lectures: 4 hrs. /week	**In semester: 50**
Credits: 4	**End semester: 50**

Objectives:

To demonstrate the effectiveness of artificial intelligent techniques to solve complex issues related to tool design

Outcome:

Student will be able to apply artificial intelligent techniques to deal with various practical issues in tool design such as:

- Automatic configuration of tooling,
- Process planning in tool design,
- Material flow analysis
- Defect analysis

Unit I
Fixture design
Applications of AI techniques for fixturing constraint analysis, Workpiece locating and Clamping stability analysis, determination of magnitude and number of clamps, Workpiece deformation under clamping and machining force. Fixture structural stiffness, applications of CAFD

Unit II
Press tool design
Applications of AI techniques for process planning in progressive dies, feature extraction and manufacturability assessment of sheet metal parts, automatic blank nesting, force calculations, forming analysis, optimization of spring back in bending & drawing operations, prediction of life of compound die.

Unit III
Forging die design
Applications of AI techniques for process planning of forging impressions, Determination of parting line, forging force analysis, material flow analysis in forging operations, computer aided forging die design.

Unit IV
Injection mould design:
Applications of AI techniques for determination of number of impressions, analysis of cooling system, mold flow analysis and solidification, defect analysis, cavity balancing, gating system design, computer aided injection mould design.

Unit V

Metal casting die design

Applications of AI techniques in cavity layout design, gating system design and analysis, solidification control, automatic generation side cores, material flow analysis, defect analysis, parting line selection, computer aided die casting die design.

Unit VI

Sand casting mold design

Model representation and verification, casting solidification, vector element method, mould filling analysis, optimal filling time, and optimal design of feeding system. Product design for castability.

References:

1. Nee A Y C., Whybrew K., Senthil Kumar A., "Advanced fixture design for FMS", Springer-Verlag, NY. ISBN: 978-1-4471-2119-0
2. Yiming Rong, "Computer-Aided Fixture Design", Manufacturing Engineering and Materials Processing Series/55, CRC Press. ISBN: 9780824799618
3. Carlos B. Bergmann, "AI applications in sheet metal forming", Springer, ISBN:9789811022517
4. Weinstein M, Manoochehri S., "Optimum parting line design of molded and cast parts for manufacturability", Journal of Manufacturing Systems, Volume 16(1), 1997, pp. 1-12.
5. Šraml M , Stupan J, Potrč I, Kramberger J., "Computer-aided analysis of the forging process, The International Journal of Advanced Manufacturing Technology, Volume 23 (3), pp. 161–168
6. Fuh J.Y.H., Fuh M. W., Nee A.Y.C., "Computer-Aided Injection Mold Design and Manufacture", CRC Press, ISBN 9780824753146
7. Ravi B., "Metal Casting: Computer - Aided Design and Analysis", Prentice-Hall India Learning Pvt. Ltd, ISBN-13: 978-8120327269

511311 Computer Aided Production Planning

Teaching Scheme	Examination Scheme
Lectures: 4 hrs. /week	In semester: 50
Credits: 4	End semester: 50

Course Objectives

- To impart knowledge on part design representation and computer aided process planning techniques
- To acquire knowledge in computer aided process planning and develop computer aided process planning system

Course Outcomes (COs)

The student will be able to

- Generate the structure of automated process planning system and uses the principle of generative and retrieval CAPP systems for automation
- Select the manufacturing sequence and explains the reduction of total set up cost for a\ particular sequence
- Predict the effect of machining parameters on production rate, cost and surface quality and determines the manufacturing tolerances

Unit I

Computer Aided Forecasting

Nature and use of forecast, sources of data, demand patterns, forecasting models, selection of forecasting technique, measurement of forecast Accuracy, Adoptive methods. Computerized relative allocation of facility technique, automated layout design program and computerized relationship layout planning for facility location and layout

Unit II

Group Technology

Introduction, objectives part families, algorithms and models for G.T. - Rank order clustering, Bond energy, mathematical model for machine – component cell formation. Design and manufacturing attributes. Parts classification and coding, concept of composite job machine group, cell group tooling, design rationalization, CAD/CAM and GT benefits.

Unit III

Computer Aided Process Planning

Computer Aided Process Planning, Operation Management, Computer Aided Inspection-Computer Aided Testing, Contact type, non-contact type

Unit IV

MRP

Introduction, Objective, Input, Computational procedure, information provided by the system. Detailed capacity planning, manufacturing resources planning

ERP: Introduction, main features, generic model of ERP system, selection of ERP, proof of concept approach, analytic hierarchy approach, ERP implementation.

Unit V

Job sequencings

Job Sequencings, scheduling, Shop floor control- data collection, and computer generated time standard.

Unit VI

Simulation

Major activities, purpose, simulation process, types methodology, simulation packages, process quality simulator, computer requirements trends, applications simulation of manufacturing systems.

Reference Books

1. An introduction to Automated Process Planning – Tien – Chien Chang and Richard Awysk/Prentice hall
2. M.P. Groover, Automation production systems and computer aided mfg.-
3. P.N.Rao, N.K.Tewari, T.K. Kundra, Computer aided manufacturing
4. John Bur bridge, Group Technology in the engineering industry
5. Carol Ptak and Chad Smith, Orlikey's Material Requirements Planning, Third Edition
6. Buffa & Sarin, Modern Production Management
7. P.B. Mahapatra, Computer Aided production management
8. Averill M Law & David Kelton, Simulation modeling and analysis, Tata Mcgraw Hill
9. N. Singh and Divakar Rajamani, Cellular Manufacturing Systems- Design, planning and control, Springer US

511312A: Tribology and Surface Engineering (Elective III)

Teaching Scheme	Examination Scheme
Lectures: 5hrs. /week	In semester: 50
Credits: 5	End semester: 50

Objectives:

- To provide detail about the concepts of friction, wear, surface treatment processes, and lubrication affecting the structure and behavior of contacting surfaces, their nature and topography
- Enable students to perform tribological measurements to practice tribological design of mechanical elements and systems

Outcomes:

Students will be able to

- Describe theories of sliding and rolling friction
- State wear and corrosion mechanisms
- Apply the knowledge of lubrication for the design of various bearings
- Perform tribological measurements
- Explain the structure of surfaces.
- Define various surface treatment processes
- Select and apply appropriate surface treatment method for corrosion prevention

Unit I

Friction Wear and Corrosion

Theory of friction- sliding and rolling friction, Tabor's model of friction, Friction properties of metallic and nonmetallic materials, friction in extreme conditions, Wear, types of wear, mechanisms of wear, wear resistant materials, Mechanisms and types of corrosion, Measurement and testing of Friction, Wear and Corrosion, Prevention of wear and Corrosion.

Unit II

Lubrication Theory

Lubricants physical properties, lubricants standards, Lubrication regimes, Hydrodynamic lubrication, Reynolds equation, Thermal, inertia and turbulent effects, Elasto, Plasto and magneto hydrodynamic lubrication, Hydrostatic, Gas lubrication. Design of fluid film bearings, Design of air bearing and gas bearing.

Unit III

Tribo Measurement and Instrumentation

Surface topography measurements, Electron microscope, Laser method, Instrumentation, International Standards, Bearing performance measurements, Bearing Vibration Measurement

Unit IV

Introduction to Surface Engineering

Concept and Scope of Surface Engineering, Mathematical modeling and manufacturing of surface layers, The solid surface-geometrical , mechanical and physico chemical concept, Three dimensional structure of surface, The superficial layer and its parameters.

Unit V

Surface Engineering for Wear and Corrosion Resistance

Diffusion Coatings, Electro and Electro-less plating, Hot dip coating, Metal Spraying, Cladded coatings, Crystallizing coatings, Flame and arc processes, Conversion coatings, selection of coatings for wear and corrosion resistance, Potential properties and parameters of coatings.

Unit VI

Thin Layer Engineering Processes

Laser and electron beam hardening, its process parameters and their effects, Physical vapor deposition, Thermal evaporation Arc vaporization, Sputtering, Chemical vapor deposition, ion implantation technique, Coating of tools, TiC, TiN, Al2O3 and Diamond coating properties, applications of thin Coatings.

Reference Books:

1. Hulling J. "Principles of Tribology" Mc Millan, 1984
2. Williams J.A. "Engineering Tribology" Oxford University press, 1994.
3. Davis J. "Surface Engineering for corrosion and Wear Resistance", Wood head Publishing, 2001.
4. Tadausz Burakowski, "Surface Engineering of Metals: Principles, Equipment's, Technologies" Taylor and Francis.

511312B: Energy Management (Elective III)

Teaching Scheme	Examination Scheme
Lectures: 5 hrs. /week	**In semester: 50**
Credits: 5	**End semester: 50**

Course objective:

- Apply concepts of thermal engineering including thermodynamics, heat transfer and fluid mechanics to design and develop energy efficient equipment.
- Adopt methods of energy conservation for sustainable development in various equipment's.
- To gather knowledge on energy auditing techniques used for energy systems.
- To work on efficient energy systems used in various electrical lighting systems.
- To understand the concept of the cogeneration, trigeneration and waste heat recovery.

Outcomes:

- Ability to understand the basic concept of energy conservation and its role in energy management.
- Learn the purpose and detailed methodology of energy audit.
- Ability to analyze the energy conservation opportunities in the energy intensive industries.
- Ability to analyze the quantum of electrical energy that can be saved by the use of energy efficient lighting systems.
- Learn the concept of cogeneration, trigeneration and waste heat recovery in detail.

Unit I
Introduction
Global and Indian energy market, Energy scenario in various sectors and Indian economy. Need and importance of energy conservation and management. Payback period. Return on Investment (ROI). Life Cycle Cost. Sankey Diagrams. Specific Energy consumption. Load Management.

Unit II
Energy Auditing
Methodology, analysis and reporting. Portable and on-line instruments, costing of utilities like steam, compressed air, electricity and water.

Unit III
Steam and Condensate Systems
Boilers (including packaged boilers), efficiency, testing, excess air and flue gas monitoring. Steam distribution. Steam traps. Condensate and flash steam utilization. Thermal insulation. Economic Thickness of Insulation (ETI).

Unit IV
Electrical systems
Demand control, power factor improvement, benefits and ways of improvement. Load scheduling. Electric motors, losses, efficiency, energy- efficient motors, motor speed control,

variable speed drive. Lighting: Illumination levels, fixtures, timers, energy efficient illumination.

Unit V

Energy conservation

Energy conservation in compressed air systems, refrigeration and air-conditioning systems and water systems. Elementary coverage of energy conservation in pumps and fans. Opportunities in Process Industries for Energy conservation.

Unit VI

Cogeneration

Concept, options (steam/ gas turbine/ DCT -based). Selection criteria, Application in various industries

Reference Books:

1. P. H. Henderson: India-The Energy Sector, Oxford university Press.
2. D. A. Ray: Industrial Energy Conservation. Pergamon Press.
3. IGC Dryden, editor: The efficient use of Energy (Butterworths).
4. W. C. Turner, editor: Energy Management handbook (Wiley).
5. Patrick Steven R., Patric Dale R., Fordo Stephen: Energy Conservation Guide book, The Fairmont Press Inc.
6. Frank Keith, Yogi Goswami, "Energy Management and End Use Efficiency Handbook", Taylor & Francis.

511312C: Human Factors in Design & Manufacturing (Elective III)

Teaching Scheme	Examination Scheme
Lectures: 5 hrs. /week	In semester: 50
Credits: 5	End semester: 50

Course objectives:

- To understand the user's (human) capabilities and limitations in seeking to ensure the tasks (job), functions, information and the environment.
- To study of humans anthropometry, biomechanics, industrial engineering, information design, human psychology

Course outcomes:

- Student will able to design industrial and consumer product by using ergonomic principles.
- Student will able to design work space and equipment used (size, shape, displays & controls) for the activity to be performed;,
- Student will able to analyse the effect of working conditions on human performance.

Unit I:
Introduction to Human Factors

Human criteria's, human physical activities, features of the human body, Measures of physiological functions such as: energy expenditure, gross body activity, local muscular activity, work load, work efficiency, work and rest. Type of movements of body members. Performance criteria for physical activity such as: Strength & endurance speed of movements, accuracy of movements, manual material handling (MMH).

Unit II:
Applied Anthropometry and Work Space
Introduction to anthropometry, use & principles of anthropometry data, work spaces, work space envelopes for seated persons, design of work spaces such as: work surface height, seated & standing, principles of seat design, workplace design. Physical space & arrangement, principles of arrangement of component.

Unit III:
Design of Displays and Controls
Information input & processing, visual displays of static & dynamic information. Auditory, textual & olfactory displays general location of controls & displays within workspace, concept of visibility. Functions of controls, types of controls, factors in control design, design of specific hand operated controls, foot controls and special control devices.

Unit IV:
Working Conditions
Illumination: Colour systems, energy consideration, effect of lighting on performance. Atmospheric conditions: Measurement of thermal variables, wet-bulb globe temperature, Botsball, heat stress index, heat index, wind chill index, physiological effect of heat & cold on

performance. Noise: Physiological effect of noise on performance, noise exposure limits, noise controls.

Unit V:
Energy Expenditure
Muscle mechanism, BMR, Heart Rate variations, Oxygen consumption, Rest allowances, Rate of energy expenditure, Manual Material Handling Capacity determination, Effect of environmental conditions and work design on Energy Expenditure.

Unit VI:
Ergonomics and Work Organization

Human factors and ergonomics standards, Human factors applications in system design, characteristics of system design, human factors data for interface design, ergonomic safety and health management, case studies of ergonomically designed product.

Text Books

1. Sanders M. S. and McCormick E. J., "Human Factors in Engineering and Design", McGraw-Hill International Editions,
2. Bridger R. S., "Introduction to Ergonomics", McGraw-Hill International Editions

Reference Books:

1.Gavriel Salvendy (Ed.). 'Handbook of human factors and ergonomics", 3rd Edition, John-Wiley and Sons

511312D: Energy Economics and Costing (Elective III)

Teaching Scheme	Examination Scheme
Lectures: 5 hrs. /week	In semester: 50
Credits: 5	End semester: 50

Course Objectives:

- To provide information on fundamentals of Financial, Economical and Costing for any manufacturing industry.

Course Outcomes:

- Understand the importance of Finance & methods of Costing.
- Describe Investment proposal from short term & Long term decisions.
- Prepare costing sheet.

Unit I
Introduction to Economics
Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics, Managerial, Economics and Macro-economic - Applications of Economics, Elementary economic Analysis – Material and design selection criteria, Process planning.

Unit II
Financial Management
Responsibilities and functions of financial management, financial analysis, ratio analysis, leverage analysis, budgeting and budgetary control, sources of finance for fixed and working capital.

Unit III
Investment Appraisal Methods
Types of investment appraisal methods – present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, make or buy decisions, Examples in all the methods, risk analysis.

Unit IV
Replacement and Maintenance Analysis
Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset – capital recovery with return and concept of challenger and defender, Simple probabilistic model for items which fail completely.

Unit V
Depreciation Analysis
Introduction, Straight line method of depreciation, declining balance method of depreciation- Sum of the years digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, machine hour basis method, production unit method, joint factor rate

method, annuity method, service output method of depreciation-Evaluation of public alternatives- introduction, Examples, Inflation adjusted decisions – procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset.

Unit VI

Costing, Cost Control and Cost Reduction

Process costing: Elements of production cost in process costing, methods of process costing, principles of process costing.

Marginal costing: Features of marginal costing, significance of marginal costing, break-even point, P/V ratio.

Standard costing and variance analysis: Direct material variances, direct labor variances, Overhead variances, sales variances.

Cost control and cost reduction, Techniques of cost control, cost reduction, areas of application.

References:

1. Dominick Salvatore, "Managerial economics in a global economy" McGraw-Hill. ISBN: 0070545995
2. Panneer Selvam, R, Engineering Economics, Prentice Hall of India Ltd, New Delhi, 2001.*ISBN: 8120317432*
3. Sasmita Mishra, Engineering Economics and Costing. PHI Learning Pvt. Ltd. ISBN: 8120338936
4. Chan S. Park, "Contemporary Engineering Economics", Prentice Hall of India, 2002. ISBN: 0136118488
5. William G. Sullivan, Elin Wicks and C. Patrick Koelling Engineering economy, Pearson Education, ISBN: 9788131734421

511313 Seminar II

Teaching Scheme	Examination Scheme
Practical's: 4 hrs/week	**Term works: 50 Marks**
Credits: 4	**Oral: 50 Marks**

Each student is required to review the literature related to proposed dissertation work to be done. He/she is required to deliver the seminar and submit it in the form of short report.

511314 Project Stage I

Teaching Scheme
Practical's: 8hrs/week
Credits: 8

Examination Scheme
Term work: 50 Marks
Oral: 50 Marks

Student has to submit a report based upon the following:

- Objective of the Project
- Problem statement
- Literature review
- Methodology
- Progress Achieved
- Difficulties encountered
- Experimental set up preparation
- Future plan of action

511315 Seminar III

Teaching Scheme	Examination Scheme
Practical's: 5 hrs/week	**Term works: 50 Marks**
Credits: 5	**Oral: 50 Marks**

Each student is required to review the literature related to the dissertation work to be done, or on any other relevant topic.
He/she is required to deliver the seminar and submit it in the form of short report.

511316 Project Stage II

Teaching Scheme
Practical's: 20hrs/week
Credits: 20

Examination Scheme
Term work: 150 Marks
Oral: 50 Marks

Student has to submit a report based upon the following:

1. Objectives of work
2. Review of literature
3. Development of methodology
4. Experimental and numerical analysis.
5. Results obtained.
6. Comparison of results with previous work done
7. Conclusions.