

ACADEMIC REGULATIONS & COURSE STRUCTURE

For

ADVANCED MANUFACTURING SYSTEMS

(Applicable for batches admitted from 2016-2017)



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA - 533 003, Andhra Pradesh, India**

I Semester

S.No.	Subject	L	P	C
1	Automation in Manufacturing	4	--	3
2	Advances in CNC Technologies	4	--	3
3	Special Manufacturing Processes	4		3
4	Design for Manufacturing and Assembly	4	--	3
5	Elective I 1. Industrial Robotics 2. Product Design 3. Total Quality Management	4	--	3
6	Elective II 1. Advanced CAD 2. Mechatronics 3. Precision Engineering	4	--	3
7	Advance CAD/CAM Lab	--	3	2
Total Credits				20

II Semester

S.No.	Subject	L	P	C
1	Modeling and Simulation of Manufacturing Systems	4	--	3
2	Quality Engineering in Manufacturing	4	--	3
3	Intelligent Manufacturing Systems	4	--	3
4	Optimization and Reliability	4	--	3
5	Elective III 1. Finite Element Methods 2. Concurrent Engineering 3. Design and Manufacturing of MEMS and Microsystems	4	--	3
6	Elective IV 1. Production and Operations Management 2. Materials Technology 3. Computational Fluid Dynamics	4	--	3
7	Manufacturing Simulation and Precision Engg. Lab	--	3	2
Total Credits				20

III Semester

S. No.	Subject	L	P	Credits
1	Comprehensive Viva-Voce	--	--	2
2	Seminar – I	--	--	2
3	Project Work Part - I	--	--	16
Total Credits				20

IV Semester

S. No.	Subject	L	P	Credits
1	Seminar – II	--	--	2
2	Project Work Part - II	--	--	18
Total Credits				20

I Year I Semester	AUTOMATION IN MANUFACTURING	L	P	C
		4	0	3

UNIT – I

OVER VIEW OF MANUFACTURING AND AUTOMATION : Production systems, Automation in production systems, Automation principles and strategies, Manufacturing operations, production facilities. Basic elements of an automated system, levels of automation; Hardware components for automation and process control, programmable logic controllers and personal computers.

UNIT – II:

MATERIAL HANDLING AND IDENTIFICATION TECHNOLOGIES: Material handling, equipment, Analysis. Storage systems, performance and location strategies, Automated storage systems, AS/RS, types. Automatic identification methods, Barcode technology, RFID.

UNIT – III:

MANUFACTURING SYSTEMS AND AUTOMATED PRODUCTION LINES: Manufacturing systems: components of a manufacturing system, Single station manufacturing cells; Manual Assembly lines, line balancing Algorithms, Mixed model Assembly lines, Alternative Assembly systems. Automated production lines, Applications, Analysis of transfer lines.

UNIT – IV:

AUTOMATED ASSEMBLY SYSTEMS: Fundamentals, Analysis of Assembly systems. Cellular manufacturing, part families, cooling, production flow analysis. Group Technology and flexible Manufacturing systems, Quantitative Analysis.

UNIT – V:

QUALITY CONTROL AND SUPPORT SYSTEMS: Quality in Design and manufacturing, inspection principles and strategies, Automated inspection, contact Vs non contact, CMM. Manufacturing support systems. Quality function deployment, computer aided process planning, concurrent engineering, shop floor control, just in time and lean production.

TEXT BOOK:

1. Automation, production systems and computer integrated manufacturing/ Mikell.P Groover/PHI/3rd edition/2012,

REFERENCES:

1. CAD/CAM/CIM/ P. Radha Krishnan & S. Subrahmanyarn and Raju/New Age International Publishers/2003.
2. System Approach to Computer Integrated Design and Manufacturing/ Singh/John Wiley /96.
3. Computer Aided Manufacturing/Tien-Chien Chang, Richard A. Wysk and Hsu-Pin Wang/ Pearson/ 2009
4. Manufacturing and Automation Technology / R Thomas Wright and Michael Berkeihiser / Good Heart/Willcox Publishers

I Year I Semester	ADVANCES IN CNC TECHNOLOGIES	L	P	C
		4	0	3

UNIT I:

Features of NC Machines Fundamentals of numerical control, advantage of NC systems, classification of NC systems, point to point, NC and CNC, incremental and absolute, open and closed loop systems, Features of NC Machine Tools, design consideration of NC machine tool, methods of improving machine accuracy. Systems Drives and Devices: Hydraulic motors, DC motors, stepping motors and AC motors, feedback devices, encoders, Induction tachometers.

UNIT II:

NC Part Programming: Manual programming-Basic concepts, Point to Point contour programming, canned cycles, parametric programming. Computer-Aided Programming: General information, APT programming, Examples APT programming problems (2D machining only). NC programming on CAD/CAM systems,

UNIT III:

Post Processors: Introduction to post processors, necessity of post processors, general structure of a post processor, functions of a post processor. Automatic tool path generation. Interpolators: DDA integrator, hardware interpolators for linear and circular interpolator, DDA software interpolators and CNC software interpolators, the reference pulse technique, sample-data technique.

UNIT IV:

Tooling for CNC machines: Inter changeable tooling system, preset and qualified tools, coolant fed tooling system, modular fixturing, quick change tooling system, automatic head changers. DNC SYSTEMS AND Adaptive Control: Introduction, type of DNC systems, advantages and disadvantages of DNC, adaptive control with optimization, Adaptive control with constraints, Adaptive control of machining processes like turning, grinding

UNIT V:

Micro Controllers: Introduction, Hardware components, I/O pins, ports, external memory, counters, timers and serial data I/O interrupts. Selection of Micro Controllers, Embedded Controllers, Applications and Programming of Micro Controllers. Programmable Logic Controllers (PLC's): Introduction, Hardware components of PLC, System, basic structure, principle of operations, Programming mnemonics timers, Internal relays and counters, Applications of PLC's in CNC Machines.

Text Books:

1. Computer Control of Manufacturing Systems / Yoram Koren / Mc Graw Hill Int. 1983.
2. Machining Tools Hand Book Vol 3, (Automation & Control)/ Manfred Weck / John Wiley and Sons, 1984.

I Year I Semester	SPECIAL MANUFACTURING PROCESS	L	P	C
		4	0	3

UNIT-I

SURFACE TREATMENT: Scope, Cleaners, Methods of cleaning, Surface coating types, and ceramic and organic methods of coating, economics of coating. Electro forming, Chemical vapor deposition, thermal spraying, Ion implantation, diffusion coating, Diamond coating and cladding.

UNIT- II

PROCESSING OF CERAMICS: Applications, characteristics, classification .Processing of particulate ceramics, Powder preparations, consolidation, Drying, sintering, Hot compaction, Area of application, finishing of ceramics. Processing of Composites: Composite Layers, Particulate and fiber reinforced composites, Elastomers, Reinforced plastics, MMC, CMC, Polymer matrix composites.

UNIT- III

FABRICATION OF MICROELECTRONIC DEVICES:

Crystal growth and wafer preparation, Film Deposition oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, computer aided design in micro electronics, surface mount technology, Integrated circuit economics.

UNIT - IV

ADVANCED MACHINING PROCESSES: EDM, WireEDM, ECM, LBM, EBM, AJM, WJM – Principle, working, limitations and applications.

UNIT -V

RAPID PROTOTYPING: Working Principles, Methods, Stereo Lithography, Laser Sintering, Fused Deposition Method, Applications and Limitations, Rapid tooling, Techniques of rapid manufacturing

TEXT BOOKS:

1. Manufacturing Engineering and Technology / Kalpakijian / Adisson Wesley, 1995.
2. Process and Materials of Manufacturing / R. A. Lindburg / 1th edition, PHI 1990.

REFERENCES:

- 1 Microelectronic packaging handbook / Rao. R. Thummala and Eugene, J. Rymaszewski / Van Nostrand Renihold,
- 2 MEMS & Micro Systems Design and manufacture / Tai — Run Hsu / TMGH
- 3 Advanced Machining Processes / V.K.Jain / Allied Publications.
- 4 Introduction to Manufacturing Processes / John A Schey / Mc Graw Hill.

I Year I Semester	DESIGN FOR MANUFACTURING AND ASSEMBLY	L	P	C
		4	0	3

UNIT - I

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.

UNIT - II

Machining processes: Overview of various machining processes-general design rules for machining-dimensional tolerance and surface roughness-Design for machining – ease – redesigning of components for machining ease with suitable examples. General design recommendations for machined parts.

UNIT - III

Metal casting: Appraisal of various casting processes, selection of casting process,-general design considerations for casting-casting tolerance-use of solidification, simulation in casting design-product design rules for sand casting.

Extrusion & Sheet metal work: Design guide lines extruded sections-design principles for punching, blanking, bending, deep drawing-Keeler Goodman forging line diagram – component design for blanking.

UNIT - IV

Metal joining: Appraisal of various welding processes, factors in design of weldments – general design guidelines-pre and post treatment of welds-effects of thermal stresses in weld joints-design of brazed joints. Forging: Design factors for forging – closed die forging design – parting lines of dies – drop forging die design – general design recommendations.

UNIT – V

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

TEXT BOOKS:

1. Design for manufacture, John cobert, Adisson Wesley. 1995
2. Design for Manufacture by Boothroyd,
3. Design for manufacture, James Bralla

REFERENCE:

1. ASM Hand book Vol.20

I Year I Semester		L	P	C
		4	0	3

**INDUSTRIAL ROBOTICS
(ELECTIVE – I)**

UNIT - I

INTRODUCTION: Automation and Robotics, Robot anatomy, robot configuration, motions joint notation scheme, work volume, robot drive systems, control systems and dynamic performance, precision of movement.

CONTROL SYSTEM AND COMPONENTS: basic concepts and motion controllers, control system analysis, robot actuation and feedback components, Positions sensors, velocity sensors, actuators, power transmission systems, robot joint control design.

UNIT - II

MOTION ANALYSIS AND CONTROL: Manipulator kinematics, position representation, forward and inverse transformations, homogeneous transformations, manipulator path control, robot arm dynamics, configuration of a robot controller.

UNIT - III

END EFFECTORS: Grippers-types, operation, mechanism, force analysis, tools as end effectors consideration in gripper selection and design. **SENSORS:** Desirable features, tactile, proximity and range sensors, uses sensors in robotics.

MACHINE VISION: Functions, Sensing and Digitizing-imaging devices, Lighting techniques, Analog to digital single conversion, image storage: Image processing and Analysis-image data reduction, Segmentation, feature extraction, Object recognition. Training the vision system, Robotic application.

UNIT - IV

ROBOT PROGRAMMING: Lead through programming, Robot program as a path in space, Motion interpolation, WAIT, SIGNAL AND DELAY commands, Branching, capabilities and Limitations of lead through methods.

ROBOT LANGUAGES: Textual robot Languages, Generations of robot programming languages, Robot language structures, Elements and function.

UNIT - V

ROBOT CELL DESIGN AND CONTROL: Robot cell layouts-Robot centered cell, In-line robot cell, Considerations in work design, Work and control, Inter locks, Error detection, Work cell controller.

ROBOT APPLICATION: Material transfer, Machine loading/unloading, Processing operation, Assembly and Inspection, Future Application.

TEXT BOOKS:

1. Industrial Robotics / Groover M P / Pearson Edu.
2. Introduction to Robotic Mechanics and Control by JJ Craig, Pearson, 3rd edition.

REFERENCES:

- 1 Robotics / Fu K S/ McGraw Hill.
- 2 Robotic Engineering / Richard D. Klafter, Prentice Hall
- 3 Robot Analysis and Intelligence / Asada and Slotine / Wiley Inter-Science.

- 4 Robot Dynamics & Control – Mark W. Spong and M. Vidyasagar / John Wiley
- 5 Introduction to Robotics by SK Saha, The McGraw Hill Company, 6th, 2012
- 6 Robotics and Control / Mittal R K & Nagrath I J / TMH

PRODUCT DESIGN (ELECTIVE - I)

UNIT- I

Introduction -Need for IPPD – strategic importance of product development – integration of customer, designer, material supplier and process planner, Competitor and customer – behavior analysis. Understanding customer – promoting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specification.

UNIT - II

CONCEPT GENERATION AND SELECTION: Task – Structured approaches – Clarification – Search – Externally and internally – explore systematically – reflect on the solutions and process – concept selection – methodology – benefits.

PRODUCT ARCHITECTURE: Implications – Product change – variety – component standardization – product performance – manufacturability.

UNIT - III

PRODUCT DEVELOPMENT MANAGEMENT: Establishing the architecture – creation – clustering – geometric layout development – fundamental and incidental interactions – related system level design issues – secondary systems – architecture of the chunks – creating detailed interface specifications.

INDUSTRIAL DESIGN: Integrate process design – Managing costs – Robust design – Integrating CAE, CAD, CAM tools – simulating product performance and manufacturing processing electronically – Need for industrial design – impact – design process.

UNIT - IV

Investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology driven products – user – driven products – assessing the quality of industrial design.

UNIT - V

DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT: Definition – Estimation of manufacturing cost – reducing the component costs and assembly costs – Minimize system complexity. Prototype basics – Principles of prototyping – planning for prototypes – Economics analysis – Understanding and representing tasks – baseline project planning – accelerating the project execution.

TEXT BOOKS:

1. Product Design and Development / Kari T. Ulrich and Steven D. Eppinger / McGraw Hill International Edns. 1999.
2. Concurrent Engg/integrated Product development / Kenneth Crow / DRM Associates, 26/3, Via Olivera, Palos Verdes, CA 90274(310)377-569, Workshop Book.

REFERENCES:

- 1 Effective Product Design and Development / Stephen Rosenthal / Business One Orwin, Homewood, 1992, ISBN, 1-55623-603-4.
- 2 Tool Design–Integrated Methods for Successful Product Engineering / Stuart Pugh / Addison Wesley Publishing, New York, NY, 1991, ISBN 0-202-41369-5.
- 3 Production and Operations Management/Chase/TMH

TOTAL QUALITY MANAGEMENT (ELECTIVE - I)

UNIT – I:

INTRODUCTION: The concept of TQM, Quality and Business performance, attitude and involvement of top management, communication, culture and management systems. Management of Process Quality: Definition of quality, Quality Control, a brief history, Product Inspection vs, Process Control, Statistical Quality Control, Control Charts and Acceptance Sampling.

UNIT – II:

CUSTOMER FOCUS AND SATISFACTION: The importance of customer satisfaction and loyalty- Crating satisfied customers, Understanding the customer needs, Process Vs. Customer, internal customer conflict, quality focus, Customer Satisfaction, role of Marketing and Sales, Buyer – Supplier relationships. Bench Marketing: Evolution of Bench Marketing, meaning of Bench marketing, benefits of bench marketing, the bench marketing process, pitfalls of bench marketing.

UNIT – III:

ORGANIZING FOR TQM: The systems approach, Organizing for quality implementation, making the transition from a traditional to a TQM organizing, Quality Circles. Productivity, Quality and Reengineering: The leverage of Productivity and Quality, Management systems Vs. Technology, Measuring Productivity, Improving Productivity Re-engineering.

UNIT – IV:

THE COST OF QUALITY: Definition of the Cost of Quality, Quality Costs, Measuring Quality Costs, use of Quality Cost Information, Accounting Systems and Quality Management.

UNIT – V:

ISO9000: Universal Standards of Quality: ISO around the world, The ISO9000 ANSI/ASQCQ-90. Series Standards, benefits of ISO9000 certification, the third party audit, Documentation ISO9000 and services, the cost of certification implementing the system.

TEXT BOOKS:

1. Total Quality Management / Joel E.Ross/Taylor and Franscis Limited
2. Total Quality Management/P.N.Mukherjee/PHI

REFERENCES:

- 1 Beyond TQM / Robert L.Flood
- 2 Statistical Quality Control / E.L. Grant / McGraw Hill.
- 3 Total Quality Management- A Practical Approach/H. Lal
- 4 Quality Management/Kanishka Bedi/Oxford University Press/2011
- 5 Total Engineering Quality Management/Sunil Sharma/Macmillan

I Year I Semester		L	P	C
		4	0	3

**ADVANCED CAD
(ELECTIVE II)**

UNIT- I:

PRINCIPLES OF COMPUTER GRAPHICS : Introduction, graphic primitives, point plotting, lines, Bresenham's circle algorithm, ellipse, transformation in graphics, coordinate systems, view port, 2D and 3D transformation, hidden surface removal, reflection, shading and generation of characters.

UNIT- II:

CAD TOOLS: Definition of CAD Tools, Types of system, CAD/CAM system evaluation criteria, brief treatment of input and output devices. Graphics standard, functional areas of CAD, Modeling and viewing, software documentation, efficient use of CAD software.

GEOMETRICMODELLING: Types of mathematical representation of curves, wire frame models wire frame entities parametric representation of synthetic curves her mite cubic splines Bezier curves B-splines rational curves.

UNIT- III:

SURFACE MODELING :Mathematical representation surfaces, Surface model, Surface entities surface representation, Parametric representation of surfaces, plane surface, rule surface, surface of revolution, Tabulated Cylinder.

UNIT- IV:

PARAMETRIC REPRESENTATION OF SYNTHETIC SURFACES: Hermite Bicubic surface, **Bezier** surface, **B-** Spline surface, COONs surface, Blending surface Sculptured surface, Surface manipulation — Displaying, Segmentation, Trimming, Intersection, Transformations (both 2D and 3D).

UNIT- V:

GEOMETRICMODELLING-3D: Solid modeling, Solid Representation, Boundary Representation (B-rep), Constructive Solid Geometry (CSG).

CAD/CAM Exchange: Evaluation of data - exchange format, IGES data representations and structure, STEP Architecture, implementation, ACIS & DXF. Design Applications: Mechanical tolerances, Mass property calculations, Finite Element Modeling and Analysis and Mechanical Assembly.

Collaborative Engineering: Collaborative Design, Principles, Approaches, Tools, Design Systems.

TEXT BOOKS:

1. Mastering CAD/CAM / Ibrhim Zeid / Mc Graw Hill International.
2. CAD/CAM Principles and Applications/ P.N.Rao/TMH/3rd Edition

REFERENCES:

- 1 CAD/CAM /Groover M.P./ Pearson education
- 2 CAD/CAM Concepts and Applications/ Alavala/ PHI
- 3 CAD / CAM / CIM, Radhakrishnan and Subramanian/ New Age
- 4 Principles of Computer Aided Design and Manufacturing/ Farid Amirouche/ Pearson
- 5 Computer Numerical Control Concepts and programming/ Warren S Seames/ Thomson.

MECHATRONICS (ELECTIVE – II)

UNIT-I

Mechatronics systems, elements, levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.

UNIT-II

Solid state electronic devices, PN junction diode, BJT, FET, DIA and TRIAC. Analog signal conditioning, amplifiers, filtering. Introduction to MEMS & typical applications.

UNIT-III

Hydraulic and pneumatic actuating systems, Fluid systems, Hydraulic and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems:

Mechanical actuating systems and electrical actuating systems.

UNIT-IV

Digital electronics and systems, digital logic control, micro processors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control.

UNIT-V

System and interfacing and data acquisition, DAQS, SCADA, A to D and D to A conversions; Dynamic models and analogies, System response. Design of mechatronics systems & future trends.

TEXT BOOKS:

1. MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran & GK Vijaya Raghavan/WILEY India Edition/2008
2. Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering by W Bolton, Pearson Education Press, 3rd edition, 2005.

REFERENCES:

- 1 Mechatronics Source Book by Newton C Braga, Thomson Publications, Chennai.
- 2 Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
- 3 Mechatronics System Design / Devdas shetty/Richard/Thomson.
- 4 Mechatronics/M.D.Singh/J.G.Joshi/PHI.
- 5 Mechatronics – Electronic Control Systems in Mechanical and Electrical Engg. 4th Edition, Pearson, 2012 W. Bolton
- 6 Mechatronics – Principles and Application Godfrey C. Onwubolu, Wlsevier, 2006 Indian print

PRECISION ENGINEERING (ELECTIVE II)

UNIT I:

CONCEPTS OF ACCURACY: Introduction – Concept of Accuracy of Machine Tools – Spindle and Displacement Accuracies – Accuracy of numerical Control Systems – Errors due to Numerical Interpolation Displacement Measurement System and Velocity lags.

UNIT II:

GEOMETRIC DIMENSIONING AND TOLERANCING: Tolerance Zone Conversions – Surfaces, Features, Features of Size, Datum Features – Datum Oddly Configured and Curved Surfaces as Datum Features, Equalizing Datums – Datum Feature of Representation – Form controls, Orientation Controls – Logical Approach to Tolerancing.

UNIT III:

DATUM SYSTEMS: Design of freedom, Grouped Datum Systems – different types, two and three mutually perpendicular grouped datum planes; Grouped datum system with spigot and recess, pin and hole; Grouped Datum system with spigot and recess pair and tongue – slot pair – Computation of Transnational and rotational accuracy, Geometric analysis and application.

UNIT IV:

TOLERANCE ANALYSIS: Process Capability, Mean, Variance, Skewness, Kurtosis, Process Capability Metrics, Cp, Cpk, Cost aspects, Feature Tolerances, Geometric Tolerances. Surface finish, Review of relationship between attainable tolerance grades and different machining process, Cumulative effect of tolerances sure fit law, normal law and truncated normal law.

UNIT V:

TOLERANCE CHARTING TECHNIQUES: Operation Sequence for typical shaft type of components, Preparation of Process drawings for different operations, Tolerance worksheets and centrally analysis, Examples, Design features to facilitate machining; Datum Features – functional and manufacturing Components design – Machining Considerations, Redesign for manufactured, Examples.

TEXT BOOKS:

2. Precision Engineering in Manufacturing/Murthy R.L./New Age International (P) limited, 1996.
3. Geometric Dimensioning and Tolerancing / James D. Meadows / Marcel Dekker inc. 1995.

REFERENCES:

- 1 Engineering Design – A systematic Approach / Matousek / Blackie & Son Ltd., London
- 2 Precision Engineering/VC Venkatesh & S Izman/TMH

I Year I Semester		L	P	C
		0	3	2

ADVANCED CAD/CAM LAB

1. Features and selection of CNC turning and milling centers.
2. Practice in part programming and operation of CNC turning machines, subroutine techniques and use of cycles.
3. Practice in part programming and operating a machining center, tool panning and selection of sequences of operations, tool setting on machine, practice in APT based NC programming.
4. Practice in Robot programming and its languages.
5. Robotic simulation using software.
6. Robo path control, preparation of various reports and route sheets, Simulation of manufacturing system using CAM software, controller operating system commands.

I Year II Semester	MODELLING AND SIMULATION OF MANUFACTURING SYSTEMS	L	P	C
		4	0	3

Unit-I

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

Unit-II

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.

Unit-III

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

Unit-IV

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

Unit-V

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

TEXT BOOKS:

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

I Year II Semester	QUALITY ENGINEERING IN MANUFACTURING	L	P	C
		4	0	3

UNIT - I

QUALITY VALUE AND ENGINEERING: An overall quality system, quality engineering in production design, quality engineering in design of production processes. Loss Function and Quality Level: Derivation and use of quadratle loss function, economic consequences of tightening tolerances as a means to improve quality, evaluations and types tolerances.(N-type,S-type and L-type)

UNIT II:

TOLERANCE DESIGN AND TOLERANCING: Functional limits, tolerance design for N-type. L-type and S-type characteristics, tolerance allocation fbr multiple components. Parameter and Tolerance Design: Introduction to parameter design, signal to noise ratios, Parameter design strategy, some of the case studies on parameter and tolerance designs.

UNIT – III

ANALYSIS OF VARIANCE (ANOVA): Introduction to ANOVA, Need for ANOVA, NO-way ANOVA, One-way ANOVA, Two-way ANOVA, Critique of F-test, ANOVA for four level factors, multiple level factors.

UNIT - IV

ORTHOGONAL ARRAYS: Typical test strategies, better test strategies, efficient test strategies, steps in designing, conducting and analyzing an experiment. Interpolation of Experimental Results: Interpretation methods, percent contributor, estimating the mean.

UNIT - V

SIX SIGMA AND THE TECHNICAL SYSTEM: Six sigma DMAIC methodology, tools for process improvement, six sigma in services and small organizations, statistical foundations, statistical methodology.

TEXT BOOK:

1. Taguchi Techniques for Quality Engineering / Phillip J. Ross / McGraw Hill/ Intl. II Edition, 1995.

REFERENCES:

1. Quality Engineering in Production systems by G. Taguchi, A. Elsayed et al, McGraw Hill Intl. Pub
1989.
2. Taguchi Methods explained: Practical steps to Robust Design / Papan P. Bagchi / Prentice Hall
Pvt. Ltd., New Delhi.

I Year II Semester	INTELLIGENT MANUFACTURING SYSTEMS	L	P	C
		4	0	3

UNIT I:

COMPUTER INTEGRATED MANUFACTURING SYSTEMS: structure and functional areas of cim system- CAD, CAPP, CAM, CAQC, ASRS. Advantages of CIM. Manufacturing Communication Systems - MAP/TOP, OSI Model, Data Redundancy, Top- down and Bottom-up Approach, Volume of Information. Intelligent Manufacturing System Components, System Architecture and Data Flow, System Operation.

UNIT II:

COMPONENTS OF KNOWLEDGE BASED SYSTEMS - Basic Components of Knowledge Based Systems, Knowledge Representation, Comparison of Knowledge Representation Schemes, Inference Engine, Knowledge Acquisition.

UNIT III:

MACHINE LEARNING - Concept of Artificial Intelligence, Conceptual Learning, Artificial Neural Networks - Biological Neuron, Artificial Neuron, Types of Neural Networks, Applications in Manufacturing.

UNIT IV:

AUTOMATED PROCESS PLANNING - Variant Approach, Generative Approach, Expert Systems for Process Planning, Feature Recognition, Phases of Process planning. Knowledge Based System for Equipment Selection (KBSES) - Manufacturing system design. Equipment Selection Problem, Modeling the Manufacturing Equipment Selection Problem, Problem Solving approach in KBSES, Structure of the KRSES.

UNIT V:

GROUP TECHNOLOGY: Models and Algorithms Visual Method, Coding Method, Cluster Analysis Method, Matrix Formation - Similarity Coefficient Method, Sorting-based Algorithms, Bond Energy Algorithm, Cost Based method, Cluster Identification Method, Extended CI Method. Knowledge Based Group Technology - Group Technology in Automated Manufacturing System. Structure of Knowledge based system for group technology (KBSCIT) — Data Base, Knowledge Base, Clustering Algorithm.

TEXT BOOKS:

1. Intelligent Manufacturing Systems/ Andrew Kusiak/Prentice Hall.
2. Artificial Neural Networks/ Yagna Narayana/PHI/2006
3. Automation, Production Systems and CIM / Groover M.P./PHI/2007

I Year II Semester		L	P	C
		4	0	3

**OPTIMIZATION AND RELIABILITY
(ELECTIVE III)**

UNIT - I

CLASSICAL OPTIMIZATION TECHNIQUES: Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – method of Lagrange multipliers, Kuhn-Tucker conditions, merits and demerits of classical optimization techniques.

UNIT - II

NUMERICAL METHODS FOR OPTIMIZATION: Nelder Mead’s Simplex search method, Gradient of a function, Steepest descent method, Newton’s method, Pattern search methods, conjugate method, types of penalty methods for handling constraints, advantages of numerical methods.

UNIT - III

GENETIC ALGORITHM (GA) : Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, draw backs of GA,

GENETIC PROGRAMMING (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP.

MULTI-OBJECTIVE GA: Pareto’s analysis, Non-dominated front, multi – objective GA, Non-dominated sorted GA, convergence criterion, applications of multi-objective problems .

UNIT – IV

APPLICATIONS OF OPTIMIZATION IN DESIGN AND MANUFACTURING SYSTEMS: Some typical applications like optimization of path synthesis of a four-bar mechanism, minimization of weight of a cantilever beam, optimization of springs and gears, general optimization model of a machining process, optimization of arc welding parameters, and general procedure in optimizing machining operations sequence.

UNIT V

RELIABILITY: Concepts of Engineering Statistics, risk and reliability, probabilistic approach to design, reliability theory, design for reliability, numerical problems, hazard analysis.

TEXT BOOKS:

1. Optimization for Engineering Design – Kalyanmoy Deb, PHI Publishers
2. Engineering Optimization – S.S.Rao, New Age Publishers
3. Reliability Engineering by L.S.Srinath
4. Multi objective genetic algorithm by Kalyanmoy Deb, PHI Publishers.

REFERENCES:

1. Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers
2. Multi objective Genetic algorithms - Kalyanmoy Deb, PHI Publishers

3. Optimal design – Jasbir Arora, Mc Graw Hill (International) Publishers
4. An Introduction to Reliability and Maintainability Engineering by CE Ebeling, Waveland Printers Inc., 2009
5. Reliability Theory and Practice by I Bazovsky, Dover Publications, 2013

FINITE ELEMENT METHODS

(ELECTIVE – III)

UNIT - I

FORMULATION TECHNIQUES: Methodology, Engineering problems and governing differential equations, finite elements., Variational methods-potential energy method, Raleigh Ritz method, strong and weak forms, Galerkin and weighted residual methods, calculus of variations, Essential and natural boundary conditions.

UNIT – II

ONE-DIMENSIONAL ELEMENTS: Bar, trusses, beams and frames, displacements, stresses and temperature effects.

UNIT – III

TWO DIMENSIONAL PROBLEMS: CST, LST, four noded and eight noded rectangular elements, Lagrange basis for triangles and rectangles, serendipity interpolation functions. Axisymmetric Problems: Axisymmetric formulations, Element matrices, boundary conditions. Heat Transfer problems: Conduction and convection, examples: - two-dimensional fin.

UNIT – IV

ISOPARAMETRIC FORMULATION: Concepts, sub parametric, super parametric elements, numerical integration, Requirements for convergence, h-refinement and p-refinement, complete and incomplete interpolation functions, pascal's triangle, Patch test.

UNIT – V

FINITE ELEMENTS IN STRUCTURAL ANALYSIS: Static and dynamic analysis, eigen value problems, and their solution methods, case studies using commercial finite element packages.

TEXT BOOK:

1. Finite element methods by Chandrabatla & Belagondu, PHI, 2011, 4th Edition

REFERENCES:

1. J.N. Reddy, Finite element method in Heat transfer and fluid dynamics, CRC press, 1994
2. Zienkiwicz O.C. & R. L. Taylor, Finite Element Method, McGraw-Hill, 1983.
3. K. J. Bathe, Finite element procedures, Prentice-Hall, 1996

CONCURRENT ENGINEERING (ELECTIVE – III)

UNIT I:

INTRODUCTION,

Extensive definition of CE - CE design methodologies - Organizing for CE - CE tool box collaborative product development

USE OF INFORMATION TECHNOLOGY

IT support - Solid modeling - Product data management - Collaborative product commerce - Artificial Intelligence - Expert systems - Software hardware co-design.

UNIT II:

DESIGN STAGE

Life-cycle design of products - opportunity for manufacturing enterprises - modality of Concurrent Engineering Design –

Automated analysis idealization control - Concurrent engineering in optimal structural design - Real time constraints.

UNIT III:

MANUFACTURING CONCEPTS AND ANALYSIS

Manufacturing competitiveness - Checking the design process - conceptual design mechanism – Qualitative, physical approach - An intelligent design for manufacturing system –

UNIT IV:

JIT system - low inventory - modular - Modeling and reasoning for computer based assembly planning - Design of Automated manufacturing.

PROJECT MANAGEMENT

Life Cycle semi realization - design for economics - evaluation of design for manufacturing cost

UNIT V

Concurrent mechanical design - decomposition in concurrent design - negotiation in concurrent engineering design studies - product realization taxonomy - plan for Project Management on new product development – bottleneck technology development.

TEXT BOOKS:

1. Integrated Product Development / Anderson MM and Hein, L. Berlin, Springer, 1987.
2. Concurrent Engineering: Automation Tools and Technology / Andrew Kusaik, John Wiley.

REFERENCES:

1. Design for Concurrent Engineering / Cleetus, J, Concurrent Engg. Research Centre, Morgantown, WV, 1992.
2. Concurrent Engineering Fundamentals: Integrated Product Development/ Prasad, Prentice Hall, 1996.
3. Successful Implementation of Concurrent Product and Process / Sammy G Sinha, Wiley, John and Sons Inc., 1998.

**DESIGN AND MANUFACTURING OF MEMS AND MICRO SYSTEMS
(ELECTIVE – III)**

UNIT I:

OVERVIEW AND WORKING PRINCIPLES OF MEMS AND MICROSYSTEMS

MEMS & Microsystems, Evolution of Micro fabrication, Microsystems & Microelectronics, Microsystems & Miniaturization, Applications of MEMS in Industries, Micro sensors, Micro actuation, MEMS with Micro actuators Micro accelerometers, Micro fluidics.

UNIT II:

ENGINEERING SCIENCE FOR MICROSYSTEMS DESIGN AND FABRICATION:

Atomic structure of Matter, Ions and Ionization, Molecular Theory of Mater and Intermolecular Force, Doping of Semiconductors, The diffusion Process, Plasma Physics, Electrochemistry, Quantum Physics

UNIT III:

ENGINEERING MECHANICS FOR MICROSYSTEMS DESIGN:

Static Bending of thin Plates, Mechanical Vibration, Thermo mechanics Fracture Mechanics, Thin-Film Mechanics, Overview of Finite Element Stress Analysis

UNIT IV:

THERMO FLUID ENGINEERING & MICROSYSTEMS DESIGN:

Overview of Basics of Fluid Mechanics in Macro and Meso scales, Basic equations in Continuum Fluid dynamics, Laminar Fluid Flow in Circular Conduits, Computational Fluid Dynamics, Incompressible Fluid Flow in Micro conduits, Fluid Flow in Sub micrometer and Nano scale, Overview of Heat conduction in Solids, Heat Conduction in Multilayered Thin films and in solids in sub micrometer scale, Design Considerations, Process Design Mechanical Design, Mechanical Design using FEM, Design of a Silicon Die for a Micro pressure Sensor.

UNIT V:

MATERIALS FOR MEMS & MICROSYSTEMS AND THEIR FABRICATION:

Substrates and Wafers, Active substrate materials, Silicon as a substrate material, Silicon Compounds, Silicon Piezoresistors, Gallium Arsenide, Quartz, Piezoelectric Crystals and Polymers, Photolithography, Ion implantation, Diffusion and oxidation, chemical and physical vapor deposition, Etching, Bulk micro manufacturing, Surface Micromachining, The LIGA Process

TEXT BOOKS:

1. MEMs & Microsystems: Design & Manufacture/ Tai-Ran Hsu/Tata Mc-Graw Hill., ed./2002
2. An Introduction to Micro electro mechanical Systems Engineering/ Maluf, M./ Artech House, Boston, 2000

REFERENCES:

- 1 Micro robots and Micromechanical Systems/ Trimmer, W.S.N/ Sensors & Actuators, vol19, no.1989.
- 2 Applied Partial Differential Equations/ Trim, D.W/ PWS-Kent Publishing/ Boston 1990.
- 3 Fundamentals of Microfabrication.Madou, M/ CRC Press, Boca Raton, 1997.
- 4 The Finite Element Method in Thermomechanics/ Hsu, T.R / Alien & Unwin, London.

I Year II Semester		L	P	C
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**PRODUCTION AND OPERATIONS MANAGEMENT
(ELECTIVE IV)**

UNIT - I

OPERATION MANAGEMENT: Definition – Objectives – Types of production systems – historical development of operations management – Current issues in operation management. Product design – Requirements of good product design – product development – approaches – concepts in product development – standardization – simplification – Speed to market – Introduction to concurrent engineering.

UNIT – II

VALUE ENGINEERING: objective – types of values – function & cost – product life cycle-steps in value engineering – methodology in value engineers – FAST Diagram – Matrix Method. Location – Facility location and layout – Factors considerations in Plant location- Comparative Study of rural and urban sites – Methods of selection plant layout – objective of good layout – Principles – Types of layout – line balancing.

UNIT - III

AGGREGATE PLANNING: definition – Different Strategies – Various models of Aggregate Planning.

Advance inventory control systems push systems – Material Requirement – Terminology – types of demands – inputs to MRP- techniques of MRP – Lot sizing methods – benefits and drawbacks of MRP –Manufacturing Resources Planning (MRP –II), Pull systems – Vs Push system – Just in time (JIT) philosophy Kanban System – Calculation of number of Kanbans Requirements for implementation JIT – JIT Production process – benefits of JIT.

UNIT - IV

PROJECT MANAGEMENT: Programming Evaluation Review Techniques (PERT) – three times estimation – critical path – probability of completion of project – critical path method – crashing of simple nature.

UNIT – V

SUPPLY CHAIN MANAGEMENT: Concepts, process of SCM, selection of channel strategy, core operations capabilities, SCM decisions, SCM models.

TEXT BOOKS:

1. Operations Management/ E.S. BuffA/ John Wiley & Sons / 2007
2. Production and Operations Management/ Chary/ Mc Graw Hill/2004

REFERENCES:

- 1 Operations Management Theory and Problems/ Joseph G. Monks / Macmillan / McGraw Hill / 3rd Edition.
- 2 Production and Operations Management - Theory and Practice by Dipak Kumar Battacharyya, Universities Press Pvt Ltd, 2012.
- 3 Production Systems Management/ James I. Riggs / John Wiley & Sons.
- 4 Operations Management/ Richard Chase/ Mc Graw Hill/2006
- 5 Production and Operation Management / Panner Selvam / PHI.
- 6 Production and Operation Analysis/ Nahima/ Mc Graw Hill/2004

MATERIALS TECHNOLOGY (ELECTIVE IV)

UNIT I:

Elasticity in metals, mechanism of plastic deformation, slip and twinning, role of dislocations, yield stress, shear strength of perfect and real crystals, strengthening mechanism, work hardening, solid solution, grain boundary strengthening. Poly phase mixture, precipitation, particle, fiber and dispersion strengthening, effect of temperature, strain and strain rate on plastic behavior, super plasticity, Yield criteria: Von-mises and Tresca criteria.

UNIT II:

Griffith's Theory, stress intensity factor and fracture Toughness, Toughening Mechanisms, Ductile and Brittle transition in steel, High Temperature Fracture, Creep, Larson – Miller parameter, Deformation and Fracture mechanism maps.

UNIT III:

Fatigue, fatigue limit, features of fatigue fracture, Low and High cycle fatigue test, Crack Initiation and Propagation mechanism and Paris Law, Effect of surface and metallurgical parameters on Fatigue, Fracture of non-metallic materials, fatigue analysis, Sources of failure, procedure of failure analysis. Motivation for selection, cost basis and service requirements, Selection for Mechanical Properties, Strength, Toughness, Fatigue and Creep.

UNIT IV:

MODERN METALLIC MATERIALS: Dual Steels, Micro alloyed, High Strength Low alloy (HSLA) Steel, Transformation induced plasticity (TRIP) Steel, Maraging Steel, Inter metallics, Ni and Ti Aluminides. Processing and applications of Smart Materials, Shape Memory alloys, Metallic Glass Quasi Crystal and Nano Crystalline Materials.

UNIT V:

NONMETALLIC MATERIALS: Polymeric materials and their molecular structures, Production Techniques for Fibers, Foams, Adhesives and Coatings, structure, Properties and Applications of Engineering Polymers, Advanced Structural Ceramics WC, TiC, TaC, Al₂O₃, SiC, Si₃N₄, CBN and Diamond – properties, Processing and applications.

TEXT BOOKS:

1. Mechanical Behavior of Materials/Thomas H. Courtney/ McGraw Hill/2 nd Edition/2000
2. Mechanical Metallurgy/George E. Dieter/McGraw Hill, 1998.

REFERENCES:

- 1 Selection and use of Engineering Materials 3e/Charles J.A/Butterworth Heiremann.
- 2 Engineering Materials Technology/James A Jacob Thomas F Kilduff/Pearson
- 3 Material Science and Engineering/William D Callister/John Wiley and Sons
- 4 Plasticity and plastic deformation by Aritzur.
- 5 Introduction to Ceramics, 2nd Edition by W. David Kingery, H. K. Bowen, Donald R. Uhlmann

COMPUTATIONAL FLUID DYNAMICS (ELECTIVE – IV)

UNIT - I

INTRODUCTION: Finite difference method, finite volume method, finite element method, governing equations and boundary conditions, Derivation of finite difference equations.

Solution methods: Solution methods of elliptical equations — finite difference formulations, interactive solution methods, direct method with Gaussian elimination. Parabolic equations—explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct method with tridiagonal matrix algorithm.

UNIT – II

HYPERBOLIC EQUATIONS: Explicit schemes and Von Neumann stability analysis, implicit schemes, multi step methods, nonlinear problems, second order one-dimensional wave equations. Burgers equations: Explicit and implicit schemes, Runge-Kutta method.

UNIT – III:

FORMULATIONS OF INCOMPRESSIBLE VISCOUS FLOWS: Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, vortex methods.

Treatment of compressible flows: potential equation, Euler equations, Navier-stokes system of equations, flow field-dependent variation methods, boundary conditions, example problems.

UNIT – IV

FINITE VOLUME METHOD: Finite volume method via finite difference method, formulations for two and three-dimensional problems.

UNIT – V:

STANDARD VARIATIONAL METHODS: Linear fluid flow problems, steady state problems, Transient problems.

TEXT BOOKS:

1. Numerical heat transfer and fluid flow / Suhas V. Patankar/ Hema shava Publishers corporation & Mc Graw Hill.
2. Computational Fluid Dynamics: Basics with applications/John D. Anderson/ Mc Graw Hill.

REFERENCES:

- 1 Computational fluid dynamics/ T. J.C'hung/ Cambridge University press,2002.
- 2 Text book of fluid dynamics/ Frank Choriton/ CBS Publishers & distributors, 1985
- 3 Computational Fluid Flow and Heat Transfer/ Muralidaran/ Narosa Publications
- 4 Fundamentals of Computational Fluid Dynamics/Tapan K. Sengupta / Universities Press.
- 5 Introduction to Theoretical and Computational Fluid Dynamics/C. Pozrikidis /Oxford University Press/2nd Edition

I Year II Semester	MANUFACTURING SIMULATION & PRECISION ENGINEERING LABORATORY	L	P	C
		0	3	2

A. MANUFACTURING SIMULATION

The students will be given training on the use and application of the following software to manufacturing problems:

1. Auto MOD Software.
2. PROMOD
3. SLAM-II
4. CAFIMS
5. Flexsim

They also learn how to write sub routines in C-language and interlinking with the above packages.

Problems for modelling and simulation experiments:

1. AGV planning
2. ASRS simulation and performance evaluation
3. Machines, AGVs and AS/RS integrated problems
4. JIT system
5. Kanban flow
6. Material handling systems
7. M.R.P. Problems
8. Shop floor scheduling etc.

B. PRECISION ENGINEERING

1. Hydraulic and Pneumatic circuits
2. Closed loop control systems
3. Study of the chip formation in turning process
4. Study of operation of tool and cutter grinder, twist drill grinder, Centreless grinder
5. Determination of cutting forces in turning
6. Experiments in unconventional manufacturing processes-AJM and study of USM, EDM, Laser Machining and Plasma spraying
7. Inspection of parts using tool makers microscope, roughness and form tester
8. Study of micro-controllers, programming on various CNC machine tools and also controllers
9. Studies on PLC programming
10. Study and programming of robots
11. Condition monitoring in machining process using acoustic emission.