R16

M.Tech – CAD/CAM

SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY
(AUTONOMOUS)
DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech (CAD/CAM)
COURSE STRUCTURE

I Year – I Semester

S.No.	Course code	Subject	L	T	P	CP
1.	16ME0401	Finite Element Methods	4	0	-	4
2.	16ME0402	Computer Integrated Manufacturing	4	0	-	4
3.	16ME0403	Geometric Modeling	4	0	-	4
4.	16ME0404	Advances in Manufacturing Technology	4	0	-	4
5.	16ME0405	Computational Methods	4	0	-	4
ELECTIVE-I						
6.	16ME0406	Quality Engineering and Manufacturing	4	0	-	4
7.	16ME0407	Computer Aided Process Planning				
8.	16ME0408	Designs For Manufacturing				
LABORATORY						
9.	16ME0409	Modeling and CNC Lab	-	-	4	2
Contact periods / week			24	0	4	26
			Total/Week 28			

I Year – II Semester

S.No.	Course code	Subject	L	T	P	CP
1.	16ME0410	Advanced Optimization Techniques	4	0	-	4
2.	16ME0411	Computer Graphics	4	0	-	4
3.	16ME0412	Robotics	4	0	-	4
4.	16ME0413	CNC Technology & programming	4	0	-	4
5.	16ME0414	Mechatronics	4	0	-	4
ELECTIVE- II						
6.	16ME0406	Quality Engineering and Manufacturing	4	0	-	4
7.	16ME0407	Computer Aided Process Planning				
8.	16ME0408	Designs For Manufacturing				
LABORATORY 1						
9.	16ME0418	Computer Aided Design Lab	-	-	4	2
Contact Periods / Week			24	0	4	26
			Total/Week 28			

II YEAR (III & IV Semesters)

S. No	Subject Code	Subject	Credits
1	16ME0419	Seminar	2
2	16ME0420	Project work	16

SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY
(AUTOMOMOUS)

M.Tech I Year-I Sem (CAD/CAM) **L T P C**
4 0 0 4

(16ME0401) FINITE ELEMENT METHODS

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

UNIT – II

ONE-DIMENSIONAL FINITE ELEMENT METHODS: Bar elements, temperature effects.Element matrices, assembling of global stiffness matrix, Application of boundary conditions, Elimination and penalty approaches, solution for displacements, reaction, stresses, temperature effects, Quadratic Element, Heat transfer problems: One-dimensional, conduction and convection problems on fins.

UNIT – III

TRUSSES: Element matrices, assembling of global stiffness matrix, solution for displacements, reaction, stresses, temperature effects.

BEAMS AND FRAMES: Element matrices, assembling of global stiffness matrix, solution for displacements, reaction, stresses.

UNIT – IV

TWO DIMENSIONAL PROBLEMS: CST, LST, four nodded and eight nodded rectangular elements, Lagrange basis for triangles and rectangles, serendipity interpolation functions. Heat Transfer problems: Conduction and convection, examples: - two-dimensional fin.

ISOPARAMETRIC FORMULATION: Concepts, sub parametric, super parametric elements, numerical integration.

UNIT – V

FINITE ELEMENTS IN STRUCTURAL DYNAMICS: Dynamic equations, Eigen value problems, and their solution methods, simple problems.

CONVERGENCE: Requirements for convergence, h-refinement and p-refinement, complete and incomplete interpolation functions, Pascal's triangle.

TEXT BOOK:

1. *Introduction to Finite element in Engineers*, Tiruapathi R Chandruputla and Ashok D. Belegundu, Pearson Publishers.2012.

REFERENCES:

1. *Finite element method in Heat transfer and fluid dynamics,* J.N. Reddy, CRCpress,1994.
2. *Finite Element Method,*Zienckiwicz O.C. & R. L. Taylor, McGraw-Hill,1983.
3. *Finite Element of Nonlinear continua,* J. N. Oden, McGraw-Hill, New York, 1971.
4. *Finite element procedures,*K. J. Bathe, Prentice-Hall, 1996.

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(AUTOMOMOUS)

M.Tech I Year-I Sem (CAD/CAM)

(16ME0402) COMPUTER INTEGRATED MANUFACTURING

L	T	P	C
4	0	0	4

UNIT – I

INTRODUCTION: Fundamental concepts in Manufacturing and Automation, Automation Strategies, Economic analysis in production, fundamentals of CAD / CAM, product cycle and CAD/CAM, Automation and CAD/CAM, Scope of CIM, Automated flow lines, Transfer mechanisms, methods of Line balancing.

UNIT – II

NUMERICAL CONTROL MACHINES: Introduction- basic components of an NC system- the NC procedure- NC coordinate system, NC motion control system- application of numerical control- Economics of Numerical control.

NC PART PROGRAMMING: Introduction - The Bunch tape in NC - Tape code format - manual part programming. NC programming with manual data input.

UNIT – III

COMPUTER CONTROLS IN NC: NC controllers' technology - Computer Numerical Control (CNC), Direct Numerical control (DNC).

GROUP TECHNOLOGY: Part families, parts classification and coding, production flow analysis, Composite part concept, Machine cell design, benefits of GT.

UNIT – IV

FLEXIBLE MANUFACTURING SYSTEMS: Components of FMS, FMS Work stations, Material Handling Systems, and Computer Control system, FMS layout configurations and benefits of FMS.

UNIT – V

COMPUTER AIDED PLANNING SYSTEMS: Approaches to Computer aided Process Planning (CAPP) - Generative and Retrieval CAPP systems, benefits of CAPP, Material Requirement Planning(MRP), mechanism of MRP, benefits, and Capacity Planning.

COMPUTER INTEGRATED MANUFACTURING: Adaptive control machining systems. adaptive control optimization system, adaptive control constraint system, applications to machining processes, computer process monitoring, hierarchical structure of computers in manufacturing, and computer process control.

TEXT BOOKS:

1. *Automation, Production systems and Computer Integrated Manufacturing Systems* – MikelP.Groover, PHI Publishers, 2008.

REFERENCES:

1. *CAD/CAM*- MikellP.Groover, and Emory W.Zimmers.Jr. PHI Publishers, 2000.
2. *Computer Aided Design and Manufacturing*, K.Lalit Narayan, K.MallikarjunaRao, MMM Sarcar, PHI Publishers,2008.
3. *CAD/CAM/CIM*, Radhakrishnan and Subramanian, New Age Publisher, 2001.

SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY
(AUTOMOMOUS)

M.Tech I Year-I Sem (CAD/CAM)

L	T	P	C
4	0	0	4

(16ME0403) GEOMETRIC MODELING

UNIT – I

INTRODUCTION: Definition, Explicit and Implicit equations, parametric equations.

CUBIC SPLINES-1: Algebraic and geometric form of cubic spline, tangent vectors, parametric space of a curve, blending functions, four point form, Reparametrization, truncating and subdividing of curves.

UNIT – II

CUBIC SPLINES-2: Graphic construction and interpretation, Composite pc curves.

BEZIER CURVES: Bernstein basis, equations of Bezier curves, Properties, Derivatives.

UNIT – III

B-SPLINE CURVES: B-Spline basis, Equations, Knot vectors, Properties, and Derivatives.

UNIT – IV

SURFACES: Bicubic surfaces, Coon's surfaces, Bezier surfaces, B-Spline surfaces, Surfaces of revolutions, Sweep surfaces, Ruled surfaces, Tabulated cylinder, Bilinear surfaces, Gaussian curvature.

UNIT – V

SOLIDS: Tricubic solid, Algebraic and Geometric form.

SOLID MODELING CONCEPTS: Wire frames, Boundary representation, Half space modeling, Spatial cell, Cell decomposition, classification problem.

TEXT BOOKS:

1. *CAD/CAM Theory & Practice*, Ibrahim Zeid, Tata McGraw Hill, 1991.
2. *Elements of Computer Graphics*, Roger & Adams Tata McGraw Hill, 2001.

REFERENCES:

1. *Geometric Modeling*, Micheal E. Mortenson, John Wiley & Sons, 2006.
2. *Computer Aided Design and Manufacturing*, K.Lalit Narayan, K.MallikarjunaRao, MMM Sarcar, PHI Publishers, 2008.

SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY
(AUTOMOMOUS)

M.Tech I Year-I Sem (CAD/CAM)

L	T	P	C
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(16ME0404) ADVANCES IN MANUFACTURING TECHNOLOGY

UNIT – I

WELDING PROCESSES: Fusion and Solid state welding process, Automation in Welding, Design aspects of welds, Weldability of aluminum alloys, titanium alloys and High strength low alloy steels, Non destructive testing of welds, Residual stresses and distortion in weldments.

SURFACE PROCESSING OPERATIONS: Plating and Related Processes, Physical Vapor Deposition, Chemical Vapor Deposition, Organic Coatings, Porcelain Enameling and other Ceramic coatings, Thermal and Mechanical Coating Processes.

UNIT – II

ABRASIVE JET MACHINING: Elements of the process, mechanics of metal removal process parameters, economic considerations, applications and limitations, recent developments.

ULTRASONIC MACHINING: Elements of the process, machining parameters, effect of parameters on surface finish and metal removal rate, mechanics of metal removal process parameters, economic considerations, applications and limitations.

UNIT – III

ELECTRO-CHEMICAL PROCESSES: Fundamentals of electro chemical machining, metal removal rate in ECM, Tool design, Surface finish and accuracy economics aspects of ECM.

WIRE EDM PROCESS: General Principle and applications of Wire EDM, Mechanics of metal removal, Process parameters, selection of tool electrode and dielectric fluids, methods of surface finishing and machining accuracy.

UNIT – IV

ELECTRON BEAM MACHINING: Generation and control of electron beam for machining, theory of electron beam machining, principle, advantages, and limitations, comparison of thermal and non-thermal processes.

PLASMA ARC MACHINING: Principle, machining parameters, effect of machining parameters on surface finish and metal removal rate, applications, limitations Laser Beam Machining:Principle, effect of machining parameters on surface finish, applications, and limitations.

UNIT – V

RAPID PROTOTYPING: Working principle methods-Steriolithography, Laser sintering, Fused deposition method, applications and limitations.

NANO TECHNOLOGY: Nano milling processes, wet milling, dry milling, nano materials, fabrication of nano tubes, advantages of nano tubes, mechanical properties.

TEXT BOOKS:

1. *Manufacturing Technology*, P. N. Rao, TMH Publishers, 2009.
2. *Fundamentals of Modern Manufacturing*, Mikell P. Groover, John Wiley & Sons Publishers, 2002.

REFERENCES:

1.*Production Technology* , HMT, Tata McGraw Hill, 2001.
2.*Manufacturing Science*, G.S.Sawhney, IK International Publishers House Pvt. Ltd, 2015.
3.*Welding Processes and Technology*, Dr.R.S. Parmer, Khanna Publishers, 2003.
4. *Introduction to Nanotechnology* - Poole and Owens, Wiley, 2003.

SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY
(AUTOMOMOUS)

M.Tech I Year-I Sem (CAD/CAM)

L	T	P	C
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(16ME0405) COMPUTATIONAL METHODS

UNIT – I

NUMERICAL METHODS TO ENGINEERING PROBLEMS: Examples, Solving sets of equations – Matrix notation – Determinants and inversion – Iterative methods – Relaxation methods – System of non-linear equations – computer programs

UNIT – II

NUMERICAL INTEGRATION: Newton-Cotes integration formulas – Simpson's rules, Gaussian quadrature. Adaptive integration

OPTIMIZATION: One dimensional unconstrained optimization, multidimensional unconstrained optimization –direct methods and gradient search methods, constrained optimization

UNIT – III

BOUNDARY VALUE PROBLEMS AND CHARACTERISTIC VALUE PROBLEMS: Shooting method – Solution through a set of equations – Derivative boundary conditions – Rayleigh – Ritz method – Characteristic value problems.

UNIT – IV

NUMERICAL SOLUTIONS OF PARTIAL DIFFERENTIAL EQUATIONS: Laplace's equations – Representations as a difference equation – Iterative methods for Laplace's equations – poisson equation – Examples – Derivative boundary conditions – Irregular and non – rectangular grids – Matrix patterns, sparseness – ADI method – Finite element method.

PARABOLIC PARTIAL DIFFERENTIAL EQUATIONS: Explicit method – Crank-Nickelson method – Derivative boundary condition – Finite element for heat flow – computer programs.

UNIT – V

HYPERBOLIC PARTIAL DIFFERENTIAL EQUATIONS: Solving wave equation by finite differences-stability of numerical method –method of characteristics-wave equation in two space dimensions-computer programs.

CURVE FITTING AND APPROXIMATION OF FUNCTIONS: Least square approximation fitting of non-linear curves by least squares –regression analysis- multiple linear regression, non linear regression - computer programs.

TEXT BOOKS:

1. *Numerical Methods for Engineers,* Steven C.Chapra, Raymond P.Canale, Tata Mc-Graw hill, 2010.
2.*Applied numerical analysis,* CurtisF.Gerald, partick.O.Wheatly,Addison-wesley,1989.
3.*Numerical methods,* Douglas J..Faires,Riched Burden, Brooks/Cole publishing company,2nd Edition 1998.

REFERENCES:

1.*Numerical Mathematics and computing,* Ward cheney&David Kincaid, Brooks/Cole publishing company, 4th Edition, 1999.
2.M*athematical Methods for Physics and Engineering,*Riley K.F.M.P.Hobson&Bence S.J, Cambridge university press,1999.

SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY
(AUTOMOMOUS)

M.Tech I Year-I Sem (CAD/CAM)

L	T	P	C
4	0	0	4

(Elective-I)

(16ME0406) QUALITY ENGINEERING AND MANUFACTURING

UNIT-I

QUALITY VALUE AND ENGINEERING: An overall quality system, quality engineering in production design, quality engineering in design production processes.

LOSS FUNCTION AND QUALITY LEVEL: Derivation and use of quadratile 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 for multiple components.

UNIT-III

PARAMETER AND TOLERANCE DESIGN: Introduction to parameter design, signal to noise ratios, parameter design strategy, Introduction to tolerance design, tolerance design using the loss function, identification of tolerance design factors.

UNIT-IV

DESIGN OF EXPERIMENTS: Introduction, Task aids and Responsibilities for DOE process steps, DOE process steps description.

ANALYSIS OF VARIANCE (ANOVA): no-WAY ANOVA, One-way ANOVA, two-way ANOVA, Critique of F-test, ANOVA for four level factors, multiple level factors.

ORTHOGONAL ARRAYS: Typical test strategies, better test strategies, efficient test strategies, conducting and analyzing an experiment.

UNIT-V

INTERPOLATION OF EXPERIMENTAL RESULTS: Interpretation methods, percent contribution, estimating the mean **ISO-9000** Quality system, BDRE,6-sigma, bench marking, quality circles-brain storming-fishbone diagram-problem analysis.

TEXT BOOKS:

1. *Taguchi Techniques for Quality Engineering*, Philip J.Ross , McGraw Hill Intl. 2nd Edition, 1995.

REFERENCES:

1. *Quality Engineering in Production systems*, G.Taguchi, A.Elasayed et al, Mc.Graw Hill Intl. Edition, 1989.
2. *Taguchi Methods Explained: Practical Steps To Robust Design*, PapanP.Bagchi , Prentice Hall Ind. Pvt. Ltd. New Delhi, 2009.

SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY
(AUTOMOMOUS)

M.Tech I Year-I Sem (CAD/CAM)

L	T	P	C
4	0	0	4

(Elective-I)

(16ME0407) COMPUTER AIDED PROCESS PLANNING

UNIT – I

INTRODUCTION TO CAPP: Information requirement for process planning system, Role of process planning, advantages of conventional process planning over CAPP, Structure of Automated process planning system, feature recognition, methods.

UNIT – II

GENERATIVE CAPP SYSTEM: Importance, principle of Generative CAPP system, automation of logical decisions, Knowledge based systems, Inference Engine, implementation, benefits.

RETRIEVAL CAPP SYSTEM: Significance, group technology, structure, relative advantages, implementation, and applications.

UNIT – III

SELECTION OF MANUFACTURING SEQUENCE: Significance, alternative manufacturing processes, reduction of total set-up cost for a particular sequence, quantitative methods for optimal selection, examples.

DETERMINATION OF MACHINING PARAMETERS: Reasons for optimal selection of machining parameters, effect of parameters on production rate, cost and surface quality, different approaches, advantages of mathematical approach over conventional approach, solving optimization models of machining processes.

UNIT –IV

DETERMINATION OF MANUFACTURING TOLERANCES: design tolerances, manufacturing tolerances, methods of tolerance allocation, sequential approach**,** integration of design and manufacturing tolerances, advantages of integrated approach over sequential approach.

GENERATION OF TOOL PATH: Simulation of machining processes, NC tool path generation, graphical implementation, determination of optimal index positions for executing fixed sequence, quantitative methods.

UNIT –V

Implementation techniques for CAPP: MIPLAN system, Computer programming languages for CAPP, criteria for selecting a CAPP system and benefits of CAPP. Computer integrated planning systems, and Capacity planning system.

TEXT BOOKS:

1. *Automation Production systems and Computer Integrated Manufacturing System* – 'MikellP.Groover, Tata McGraw Hill, 2001.
2. *Computer Aided Design and Manufacturing,* Dr.Sadhu Singh, Khanna Publishers, 2009.

REFERENCES:

1. *Computer Aided Engineering,* David Bedworth, Tata McGraw Hill , 2001.
2. *Computer Aided Design & Manufacturing,* Rarid M.L Amirouche, Prentice Hall, 1992.
3. *Computer Aided Design & Manufacturing; Methods & Tools*, U.Rembold and R Dillmann- Springer, 2000.

SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY
(AUTOMOMOUS)

M.Tech I Year-I Sem (CAD/CAM)

L	T	P	C
4	0	0	4

(Elective-I)

(16ME0408) DESIGN FOR MANUFACTURING

UNIT – I

INTRODUCTION: Design philosophy-steps in design process-general design rules for manufacturability-basic principles of designing for economical production-creativity in design.

MATERIALS: Selection of materials for design-developments in material technology-criteria for material selection-material selection interrelationship with process selection-process selection charts.

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

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.

UNIT – III

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.

UNIT – IV

FORGING: Design factors for forging – closed die forging design – parting lines of dies – drop forging die design – general design recommendations.

UNIT – V

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.

PLASTICS: Visco elastic and creep behavior in plastics-design guidelines for plastic components-design considerations for injection moulding – design guidelines for machining and joining of plastics.

TEXT BOOKS:

1. *Design for Manufacture*, John cobert, Adisson Wesley. 1995.
2. *Product Design for Manufacture and Assembly*, Boothroyd, Geoffey, CRC, 3rd Edition, 2010.

REFERENCES:

1. ASM Hand book Vol.1
2. *Design for Manufacturability*, David M. Anderson, CRC, 2014.
3. *Product Design for Manufacturing* , James G. Bralla , Mcgraw Hill Inc, 2009.

SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY
(AUTOMOMOUS)

M.Tech I Year-I Sem (CAD/CAM)

L	T	P	C
0	0	4	2

(16ME0409) MODELLING AND CNC LAB

A – MODELLING

1. Generation of the following curves using "C" language
   i. Bezier curves
   ii. Splines
   iii. B-Splines.

2. Generation of the following surfaces using "C" language
   i. Bezier surfaces
   ii. B-Splines surfaces

3. Generation of solids using "C"
   i. Constructive solid geometry
   ii. Boundary representation

4. Typical tasks of Modeling using PRO/E,IDEAS, CATIA solid modeling packages
   Surface modeling
   Solid Modeling
   Drafting and
   Assembly

B – ANALYSIS

Finite Element Analysis using Ansys Package for different structures that can be discretized with 1-D,2-D & 3-D elements to perform the following analysis:

1. Static Analysis
2. Modal Analysis
3. Thermal Analysis
4. Transient analysis

SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY
(AUTOMOMOUS)

M.Tech I Year-II Sem (CAD/CAM)

L	T	P	C
4	0	0	4

(16ME0410) ADVANCED OPTIMIZATION TECHNIQUES

UNIT – I

LINEAR PROGRAMMING: Two-phase simplex method, Big-M method, duality, interpretation, applications.

ASSIGNMENT PROBLEM: Hungarian's algorithm, Degeneracy, applications, unbalanced problems, traveling salesman problem.

UNIT – II

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.

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

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.

UNIT – IV

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

UNIT V

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.

TEXT BOOKS:

1. *Optimal design*, Jasbir sing Arora, McGraw Hill, Publishers, Fourth Edition, 2012
2. *Optimization for Engineering Design*, Kalyanmoy Deb, PHI Publishers , 2nd Edition, 2012
3. *Engineering Optimization* – S.S.Rao, New Age Publishers, Forth Edition , 2009

REFERENCES:

1. *Foundation of generic Optimization*,R. Lowen and A.Verschoren, Spinger publishers, 2008
2.*Genetic Programming*, John R . Koza. Forrest H BENNett, MK Publishers,1999.
3. *Multi objective Optimization*, Kalyanmoy Deb, PHI Publishers, 2004.

SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY
(AUTOMOMOUS)

M.Tech I Year-II Sem (CAD/CAM)

L	T	P	C
4	0	0	4

(16ME0411)COMPUTER GRAPHICS

UNIT – I

INTRODUCTION TO COMPUTER GRAPHICS: Color CRT raster scan monitors, plasma display & liquid crystal display monitors, computer input devices, hard copy devices.

RASTER SCAN GRAPHICS: Line drawing algorithms – DDA &Bresenham algorithms, circle generation, general function rasterization, displaying lines, characters and polygons.

UNIT – II

FILLING ALGORITHMS: polygon filling, edge fill algorithm, seed fill algorithm, fundamentals of antialiasing and half toning.

LINE CLIPPING: Simple visibility algorithm, Cohen-Sutherland subdivision line clipping algorithm, mid point sub division algorithm.

UNIT – III

POLYGON CLIPPING: polygon clipping, reentrant polygon clipping – Sutherland – Hodgeman algorithm, character clipping, 3D- clipping.

TRANSFORMATIONS: Cartesian and homogeneous coordinate systems two dimensional and three dimensional transformations – scaling, rotation, Shearing, Zooming, viewing transformation, reflection, rotation about an axis, concatenation.

UNIT – IV

RENDERING: Hidden line removal algorithms, surface removal algorithms, painters, Warnock, Z-buffer algorithm.

UNIT – V

SHADING ALGORITHMS: Constant intensity algorithm, Phong's shading algorithm, gourand shading algorithm, Comparison of shading algorithms.

TEXT BOOKS:

1. *Procedural elements for computer graphics*, D.F.Rogers, Tata McGraw-Hil, 1985.

2. *Computer Graphics*, Donald Hearn & M.P. Bakers, Person Education Publishers, 2nd Edition, 2008.

3.**Computer Graphics***A Programming Approach*-S**Harrington**, McGraw HillPublishing Co., 7th Edition, 1987.

REFERENCES:

1. *Computer Graphics*-Donald Hearn & M.P. Bakers Tata McGraw-Hill, 2014.

2. **Computer Graphics** *Programming, GKS –The Graphics Standard*, EnderleG.,Kansy K. AndPfaff G., 2ndEdition, Springer, 2014.

SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY
(AUTOMOMOUS)

M.Tech I Year-II Sem (CAD/CAM)

L	T	P	C
4	0	0	4

(16ME0412) ROBOTICS

UNIT – I

INTRODUCTION AND ROBOT KINEMATICS: Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – End effectors – Sensors. Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects.

UNIT – II

MATRIX TRANSFORMATIONS: Introduction, robots as a mechanisms, matrix representation-representation of a point in a space, representation of a vector in space, representation of a frame at the origin of a reference frame, representation of a frame in a reference frame, representation of a rigid body. Homogeneous transformation matrices, representation of a pure translation, pure rotation about an axis, representation of combined transformations, transformations relative to the rotating, inverse of transformation matrices.

UNIT – III

DIFFERENTIAL MOTIONS AND VELOCITIES: Introduction, differential relationship, Jacobian, differential motions of a frame-translations, rotation, rotating about a general axis, differential transformations of a frame. Differential changes between frames, differential motions of a robot and its hand frame, calculation of Jacobian, relation between Jacobian and the differential operator, Inverse Jacobian.

UNIT – IV

DYNAMIC ANALYSIS AND FORCES: Introduction, Lagrangian mechanics, Effective moments of inertia, dynamic equations for multi-degree of freedom robots-kinetic energy,potential energy, the Lagrangian,robot's equations of motion, static force analysis of robots.

TRAJECTORY PLANNING: Introduction, path Vs trajectory, basics of trajectory planning, joint space trajectory planning-third order polynomial trajectory planning, fifth order polynomial trajectory planning, Cartesian-space trajectories.

UNIT – V

ROBOT SENSORS: Introduction, sensor characteristics, Position sensors-potentiometers, encoders, LVDT, Resolvers, time of travel displacement sensor, Velocity sensors-Encoders, Tachometers, differentiation of position signal, Accelerating sensors, force and pressure sensors-piezoelectric, force sensing resistor, strain gauges, Torque sensors, light and infrared sensors, touch and tactile sensors, proximity sensors-magnetic proximity sensors, optical

proximity sensors, Ultrasonic proximity sensors, inductive proximity sensors, capacitive proximity sensors, eddy current proximity sensors, sniff sensors.

TEXT BOOKS:

1. *Introduction to Robotics – Analysis, System, Applications*, Saeed B. Niku, PHI Publications.2011.
2. *Robotics Control, Sensing, Vision and Intelligence,* K.S.Fu, R.C. Gonzalez and C.S.G. Lee, McGraw Hill, 1987.
3. *Industrial Robotics* – Mikell P. Groover& Mitchell Weiss, Roger N. Nagel,NicholasG.Odrey – McGraw Hill, 1986.

REFERENCES:

1. *Robot Modeling and Kinematics* – RachidManseur, Firewall Media Publishers (An imprint of Laxmi Publications Pvt. Ltd., New Delhi), 2007.
2. *Robot Analysis and Control* - H. Asada and J.J.E. Slotine John Willey & Sons, 1987.
3. *Fundamentals of Robotics*: Analysis and control, Robert J. Schilling, Prentice Hall, 1990.
4. *A robot Engineering text book* – Mohsen shahinpoor, Harper & Row Publishers,1987.
5. *Introduction to Robotics: Mechanics and Control,* John.J.Craig, Addison- Wesley, 1999.
6. *Modeling and control of Robot manipulators*, L. sciavicco and b. Siciliano, Springer (second edition) 2000.
7. *ROBOTICS (Fundamental concepts and analysis*)ASHITAVA GHOSAL.Oxford university press Y.M.C.A.Librarybuilding.jaisingh Road.NEWDELHI-110001, 1989.

SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY
(AUTOMOMOUS)

L	T	P	C
4	0	0	4

M.Tech I Year-II Sem (CAD/CAM)

(16ME0413) CNC TECHNOLOGY & PROGRAMMING

UNIT – I

INTRODUCTION TO CNC MACHINE TOOLS: Evolution of Computerized control in manufacturing, Components, Working principle of CNC, DNC and Machining centers.

CONSTRUCTIONAL FEATURES OF CNC MACHINE TOOLS: Introduction, Spindle drives, Transmission belting, axes feed drives, Slide ways, Ball screws.

UNIT – II

ACCESSORIES: Work tables, Spindles, Spindle heads, Beds and Columns, Tooling – Automatic Tool changer (ATC).

FEEDBACK DEVICES: Introduction, Digital incremental displacement measuring systems, Incremental rotary encoders, Moire fringes, Digital absolute measuring system.

UNIT – III

ELECTRO-MAGNETIC ANALOGUE POSITION TRANSDUCERS: Principle, advantages, characteristics, Synchros, Synchro-Resolvers, Inductors, Laser interferometer.

CONTROL SYSTEMS AND INTERFACE: Open and closed loop systems, Microprocessor based CNC systems, block diagram of typical CNC system, description of hard ware and soft interpolation systems, Standard and optional features of CNC control systems.

UNIT – IV

APT PROGRAMMING: APT language structure, APT geometry, Definition of point, time, vector, circle, plane, patterns and matrices. APT motion commands: setup commands, point-to point motion commands, continuous path motion commands, post processor commands, control commands, Macro subroutines, Part programming preparation for typical examples.

UNIT – V

ECONOMICS AND MAINTENANCE OF CNC MACHINE TOOLS: Introduction, factors influencing selection of CNC machines, Cost of operation of CNC machines, Maintenance features of CNC machines, Preventive maintenance, Documentation, Spare parts, Training in Maintenance.

TEXT BOOKS:

1.*Computer Numerical Control Machines* – Dr.RadhaKrishnanan, New Central Book Agency,1989.

2.*Computer Numerical Control Machines* – Hans B.Keif and T. Frederick Waters Macmillan/McGraw Hill,2012.

REFERENCES:

1.*CNC Machines* – B.S. Aditahn and Pabla, new age international publishers,2005.

2.*CNC Machining technology* – Graham T. Smith, Springer – Verlag,1993.

3.*Computer Numerical Machine tools* - G.E. Thyer, NEWNES , second Edition,1991.

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(16ME0414) MECHATRONICS

UNIT – I

INTRODUCTION: Definition of Mechatronics products, design considerations and tradeoffs. Overview of Mechtronic products. Intelligent machine Vs Automatic machine economic and social justification.

UNIT – II

ACTUATORS AND DRIVE SYSTEMS: Mechanical, Electrical, hydraulic drive systems, Characteristics of mechanical, Electrical, Hydraulic and pneumatic actuators and their limitations. **Motion Control:** Control parameters and system objectives, Mechanical Configurations, Popular control system configurations. S-curve, motor/load inertia matching, design with linear slides.

UNIT – III

MOTION CONTROL ALGORITHMS: Significance of feed forward control loops, shortfalls, fundamentals concepts of adaptive and fuzzy – control. Fuzzy logic compensatory control of transformation and deformation non- linearity's.

ARCHITECTURE OF INTELLIGENT MACHINES: Introduction to Microprocessor and programmable logic controls and identification of systems. System design classification, motion control aspects in design.

UNIT – IV

MANUFACTURING DATA BASES: Data base management system, CAD/CAM data bases, graphic data base, introduction to object oriented concepts, objects oriented model language interface, procedures and methods in creation, edition and manipulation of data.

UNIT – V

SENSOR INTERFACING: Analog and digital sensors for motion measurement, digital transducers, human-Machine and machine- Machine inter facing devices and strategy.

MACHINE VISION: Feature and pattern recognition methods, concepts of perception and cognition in decision-making.

TEXT BOOKS:

1. *Mechatronics and the design of intelligent machines & system*-D,Bradley , D.Seward, D.Dawson, S.Burge , Stanley Thornes Publishers LTD,2000.

2. *Designing intelligent machines,* Open University, London.MichelB.Histand and davidG. Alciatore, 1987.

3. *Introduction to Mechatronics and Measurement systems,*.DavidG.Alciatore R MichesB.Histand, Tata McGraw Hill,2008.

REFERENCES:

1. Control sensors and actuators, CW. desilva,CRC press Taylor Group ,2007.

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M.Tech I Year-II Sem (CAD/CAM)

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(ELECTIVE-II)
(16ME0415) RAPID PROTOTYPING

UNIT-I

INTRODUCTION: Need for the compression in product development, History of RP system, Survey of applications, Growth of RP industry and classification of RP system. **Stereo Lithography System:** Principle, Process parameter, Process details, Data preparation, Data files and machine details, Applications.

UNIT-II

FUSION DECOMPOSITION MODELING: Principle, process parameter, Path generation, Applications.

Solid

ground curing: Principle of operation, Machine details, Applications,

LAMINATED OBJECT MANUFACTURING: Principle of Operation, LOM materials, Process details, Applications.

UNIT –III

CONCEPTS MODELERS: Principle, Thermal jet printer, Sander's model market, 3-D printer, GenisysXs printer HP system 5, Object Quadra system.

UNIT –IV

LASER ENGINEERING NET SHAPING (LENS)

RAPID TOOLING: Indirect Rapid tooling- Silicon rubber tooling- Aluminum filled epoxy tooling Spray metal tooling, Cast kriksite, 3Q keltool, etc, Direct Rapid Tooling Direct. AIM, Quick cast process, Copper polyamide, Rapid Tool, DMILS, Prometal, Sand casting tooling, Laminate tooling soft, Tooling vs. hard tooling.

SOFTWARE FOR RP: STL files, Overview of Solid view, magics, imics, magic communication, etc. Internet based software, Collaboration tools.

UNIT V

RAPID MANUFACTURING PROCESS OPTIMIZATION: Factors influencing accuracy, Data preparation error, Part building error, Error in finishing, Influence of build orientation.

ALLIED PROCESS: Vacuum casting, surface digitizing, Surface generation from point cloud, Surface modification- Data transfer to solid models.

TEXT BOOKS:

1. *Rapid manufacturing*- N.Hopkinson , RJM Hauge, Wiley publishers, 2006.
2. *Stereo lithography and other RP & M Technologies*, Paul F.Jacobs SME, NY, 1996.
3. *Rapid prototyping & Engineering applications*- Frank w. Liou CRC Press Taylor & Francis Group, 2007.

REFERENCES:

1. *Rapid Manufacturing* -Flham D.T &Dinjoy S.S , Verlog London , 2004.
2. *Rapid automated*-Lament wood, Indus Press New York, 1984.

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(ELECTIVE -II)
(16ME0416) ARTIFICIAL INTELLIGENCE & EXPERT SYSTEMS

UNIT-I

ARTIFICIAL INTELLIGENCE : Introduction, definition, underlying assumption, Important of Al, Al & related fields State space representation, defining a problem, production systems and its characteristic, search and control strategies –Introduction, preliminary concepts, examples of Search , problems.

UNIFORMED OR PRELIMINARY CONCEPT: Examples of search problems, Uniformed or Blind Search, Informed Search, Or Graphs, Heuristic Search techniques- Generate and Test, Hill climbing, Best first search, Problem reduction, Constraint satisfaction, Means- Ends Analysis.

UNIT II

KNOWLEDGE REPRESENTATION ISSUES: Representations and Mapping, Approaches, Issues in Kr, Types of knowledge procedural Vs Declarative, Logic programming, Forward Vs Backward reasoning, Matching, Non monotonic reasoning and it logic.

USE OF PREDICATE LOGIC: Representing simple facts, Instance and is a relationships, Syntax and Semantics for Propositional logic, FOPL.

UNIT -III

STATISTICAL AND PROBABILISTIC REASONING: Symbolic reasoning under uncertainly, Probability and Bayes theorem, Certainty factors and Rule based systems, Bayesian Networks, Dempster- Shafer Theory, Fuzzy Logic

UNIT -IV

EXPERT SYSTEMS: Introduction, Structure and uses, Representing and using domain knowledge, Expert System Shells. Pattern recognition, introduction, Recognition and classification process, learning classification patterns, recognizing and understanding speech.

UNIT -V

INTRODUCTION TO KNOWLEDGE ACQUISITION: Types of learning, General learning model, and performance measures.

TYPICAL EXPERT SYSTEMS: MYCIN, Variants of MYCIN, PROSPECTOR DENDRAL, PRUFF etc.

INTRODUCTION TO MACHINE LEARNING: Perceptons, Checker Playing examples, Learning, Automata, Genetic Algorithms, Intelligent Editors.

TEXT BOOKS:

1. *Artificial Intelligence* ,Elaine Rich & Kevin Knight, M/H 1983.
2. *Artificial Intelligence in Business*, Science & Industry – WendryB.RanchVol -II application, Ph 1985.

REFERENCES:

1. *A Guide to Expert System* –Waterman, D.A., Addison, Wesley inc. 1986.
2. *Building expert system*,Hayes, Roth, Waterman, “” D.A (ed), AW 1983.
3. S.M. and Kulliknowske, “Designing Expert System”, Weis, London Champion Hull 1984.

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M.Tech I Year-II Sem (CAD/CAM)

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(ELECTIVE -II)

(16ME0417) MECHANICS AND MANUFACTURING METHODS OF COMPOSITES

UNIT – I

BASIC CONCEPTS AND CHARACTERISTICS: Geometric and Physical definitions, natural and man-made composites, Aerospace and structural applications, types and classification of composites, **REINFORCEMENTS:**Fibres- Glass, Silica, Kevlar, carbon, boron, silicon carbide, and born carbide fibres. Particulate composites, Polymer composites, Thermoplastics, Thermosetts, Metal matrix and ceramic composites.

UNIT – II

MICROMECHANICS: Unidirectional composites, constituent materials and properties, elastic properties of a lamina, properties of typical composite materials, laminate characteristics and configurations. Characterization of composite properties.

UNIT – III

COORDINATE TRANSFORMATIONS: Hooke's law for different types of materials, Hooke's law for two dimensional unidirectional lamina, Transformation of stress and strain, Numerical examples of stress strain transformation, Graphic interpretation of stress – strain relations. Off - axis, stiffness modulus, off - axis compliance.

UNIT – IV

ELASTIC BEHAVIOR OF UNIDIRECTIONAL COMPOSITES: Elastic constants of lamina, relation ship between engineering constants and reduced stiffness and compliances, analysis of laminated composites, constitutive relations.

STRENGTH OF UNIDIRECTIONAL LAMINA: Micro mechanics of failure, Failure mechanisms, Strength of an orthotropic lamina, Strength of a lamina under tension and shear maximum stress and strain criteria, application to design.

UNIT – V

ANALYSIS OF LAMINATED COMPOSITE PLATES : Introduction, thin plate theory, specially orthotropic plate, cross and angle ply laminated plates, problems using thin plate theory.

MANUFACTURING METHODS: Autoclave, tape production, moulding methods, filament winding, man layup, pultrusion, RTM.

TEXT BOOKS:

1. *R. M. Jones, Mechanics of Composite Materials,* McGraw Hill Company, New York,1975.
2. *Engineering Mechanics of Composite Materials* by Isaac and M.Daniel, Oxford University Press, 1994.

REFERENCES:

1. *Analysis and performance of fibre Composites,* B. D. Agarwal and L. J. Broutman, Wiley-Interscience, New York, 1980.
2.*Analysis of Laminated Composite Structures,* L. R. Calcote ,Van NostrandRainfold, New York, 1969.

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(16ME0418) COMPUTER AIDED DESIGN LAB

PART A

Practice in part programming and operating of a machining centre tool planning and selection of sequences of operations.

Tool setting on a machine,

Practice in APT based NC programming.

PART B

1.Generation of part programs on CNC Lathe machine to perform the following Operations:

i) Step Turning
ii) Taper Turning and

2.Part program for thread cutting using canned cycle
3.Generation of part programs on CNC drilling machine
4. Generation of part programs on CNC milling machine to perform

i) Slot milling
ii) End milling and

5. Cutting tool path generation using any one simulation package for different machining Operations
6. Graphical simulation of tool path
Suggested Software Packages: PRO/E, I-DEAS, Uni-graphics, Iron CAD, Edge-CAM etc.

PART C

Practice in Robot programming and its languages. Robot simulation using software. Robot path control Simulation of Manufacturing system using CAM software, controller operating system commands