DETAILED SYLLABUS OF M.TECH (CAD & CAM) EVENING COURSE WITH EFFECT FROM 2019-2020 ACADEMIC YEAR

FIRST SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 101 COMPUTER GRAPHICS

Periods per week : 4 Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs. Credits : 3

Geometry and line generation: Line segments, Pixels and frame buffers, Bresenham's algorithms: line, circle, ellipse generation.

Graphics primitives: Primitive operations, The display-file interpreter, Display-file structure, Display-file algorithms.

Polygons: Polygons representation, An inside test, Filling polygons, Filling with a pattern.
Transformations: Scaling transformations, Reflection and zooming, Rotation, Homogeneous coordinates and translation, Rotation about an arbitrary point.

Segments: The segment table, Segment creation, Closing a segment, Deleting a segment.
Windowing and clipping: The viewing transformation, Clipping, The clipping of polygons, Generalized clipping.

Three dimensions: 3D geometry, 3D primitives, 3D transformations, Parallel projection, Perspective projection, Isometric projections, Viewing parameters, Special projections.
Hidden surfaces and lines: Back-face removal, Back-face algorithms, The Painter's algorithm, Warnock's algorithm, Franklin algorithm, Hidden-line methods.

Light, color and shading: Point-source illumination, Shading algorithms, Shadows, Color models.

Curves and fractals: Curve generation, Interpolation, B splines, Curved surface patches, Bezier curves, Fractals, Fractal lines, Fractal surfaces.

References:

1. Computer Graphics - A Programming Approach by Steven Harrington, McGraw-Hill International Edition, 1987.
2. Schaum's Outline of Theory and Problems of Computer Graphics by Roy A. Plastock and Gordon Kalley, McGraw-Hill Companies, Inc., 1986.
3. Mathematical Elements for Computer Graphics by David F. Rogersadn Adams.

FIRST SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 102 INTEGRATED COMPUTER AIDED DESIGN

Periods per week : 4 Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs. Credits : 3

Fundamentals of CAD: Introduction, Design process, Application of computer for design, Creating the manufacturing database, Benefits of CAD, Design work station, CAD hardware.

Geometric modeling: Geometric modeling techniques - Multiple view 2D input, Wire frame geometry, Surface models, Geometric entities - Curves and Surfaces, Solid modelers, Feature recognition.

Computer aided drafting: AutoCAD tools, 3D model building using solid primitives and boolean operations, 3D model building using extrusion, Editing tools, Multiple views: Orthogonal, Isometric.

Visual realism: Shading solids, Coloring, Color models, Using interface for shading and coloring. Graphic aids: Geometric modifiers, Naming scheme, Layers, Grids, Groups, Dragging and rubber banding.

Computer animation: Conventional animation, Computer animation - Entertainment animation, Engineering animation, Animation types, Animation techniques.
Mechanical assembly: Assembly modeling, Part modeling, Mating conditions, Generation of assembling sequences, Precedence diagram, Liaison-sequence analysis.

Mechanical tolerancing: Tolerance concepts, Geometric tolerancing, Types of geometric tolerances, Location tolerances, Drafting practices in dimensioning and tolerancing, Tolerance analysis.

Mass property calculations: Geometrical property formulation - Curve length, Cross-sectional area, Surface area, Mass property formulation - Mass, Centroid, Moments of inertia, Property mapping. Properties of composite objects.

References:

1. CAD/CAM Theory and Practice by Ibrahim Zeid.
2. CAD/CAM Principles and Applications by P.N. Rao, Tata McGraw Hill Publishing Company Ltd.
3. CAD/CAM Computer Aided Design and Manufacturing by Mikell P. Groover and Emory W. Zimmer, Jr.
4. Computer Integrated Design and Manufacturing by David D. Bedworth, Mark R. Henderson, Philip M. Wolfe.

FIRST SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 103 CNC AND APT PROGRAMMING

Periods per week : 4 Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs. Credits : 3

Introduction: NC, DNC, CNC, Programmed Automations, Machine control unit, Part program, NC tooling.

NC machine tools: Nomenclature of NC machine axes, Types of NC machine tools, Machining centres, Automatic tool changes (ATC), Turning centres.

Machine control unit & tooling: Functions of MCU, NC actuation systems, Part program to command signal, MCU organization, Computerized numerical control, Transducers for NC machine tools, Tooling for NC machining centres and NC turning machines, Tool presetting.

Manual part programming: Part program instruction formats, Information codes: Preparatory function, Miscellaneous functions, Tool code and tool length offset, Interpolations, Canned cycles. Manual part programming for milling operations, Turning operations, Parametric subroutines.

Computer aided part programming: NC languages: APT, NELAPT, EXAPT, GNC, VNC, Preprocessor, Post processor.

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, complication control commands. Macro subroutines. Part programming preparation for typical examples.

References:

1. Numerical Control and Computer Aided Manufacturing by T.K. Kundra, P.N. Rao and N.K. Tewari, Tata McGraw-Hill Company Limited, New Delhi.
2. Numerical Control of Machine Tools by YoramKoren and Joseph Ben-Uri, Khanna Publishers, Delhi.

FIRST SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 104 ROBOTICS

Periods per week : 4 Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs. Credits : 3

Introduction, Transformations and kinematics: Historical development, A sense of mechanisms, Robotic systems, Classification of robots, Position, orientation and location of a rigid body, Mechanics of robot manipulators. Objectives, Homogeneous coordinates, Homogeneous transformations, Coordinate reference frames, Some properties of transformation matrices, Homogeneous transformations and the manipulator: The position of the manipulator in space, Moving the base of the manipulator via transformations, Moving the tool position and orientation. Position analysis of serial manipulators: Link parameters and link coordinate systems, Denavit-Hartenberg homogeneous transformation matrices, Loop-closure equations, Other coordinate systems, Denavit-Hartenberg method: Position analysis of a planar 3-DOF manipulator: Direct kinematics, Inverse kinematics, Method of successive screw displacements, Wrist centre position. Position analysis of parallel manipulators: Structure classification of parallel manipulators, Denavit- Hartenberg method versus geometric method, Position analysis of a planar 3RRR parallel manipulator, Geometry, Inverse kinematics and Direct kinematics, Position analysis of a spatial orientation mechanism.
Jacobian analysis of serial manipulators: Differential kinematics of a rigid body, Differential kinematics of serial manipulators, Screw coordinates and screw systems, Manipulator Jacobian matrix.
Trajectory generation: General considerations in path description and generation, Joint space schemes, Cartesian space schemes, Geometric problems with Cartesian paths, Path generation at run time, Description of paths, Planning paths using the dynamic model, Collision-free path planning.
Robot Programming: Robot languages: AL, AML, RAIL, RPL, VAL, Demonstration of points in space: Continuous path (CP), Via points (VP), Programmed points (PP).

Text Book:

1. Robot Analysis - The Mechanics of Serial and Parallel Manipulators by Lung-Wen Tsai, John Wiley & Sons, Inc.

References:

1. Introduction to Robotics - Mechanics and Control by John J. Craig, Addison-Wesley Longman Inc., 1999.
2. Robotic Engineering - An Integrated Approach by Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, Prentice-Hall of India Private Limited, 1994.
3. Robotics and Control by Mittal &Nagrath, Tata McGraw Hill Company Ltd.

FIRST SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 105 Elective Subject-I
A) ADVANCED OPTIMIZATION TECHNIQUES

Periods per week : 4 Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs. Credits : 3

Geometric programming (G.P): Solution of an unconstrained geometric programming, differential calculus method and arithmetic method. Primal dual relationship and sufficiency conditions. Solution of a constrained geometric programming problem (G.P.P), Complementary Geometric Programming (C.G.P)
Dynamic programming(D.P): Multistage decision processes. Concepts of sub optimization and Principal of optimality, computational procedure in dynamic programming calculus method and tabular methods. Linear programming as a case of D.P. and continuous D.P.
Integer programming(I.P): Graphical representation. Gomory's cutting plane method. Bala's algorithm for zero-one programming problem. Branch-and-bound method, Sequential linear discrete Programming, Generalized penalty function method.
Stochastic Programming (S.P): Basic Concepts of Probability Theory, Stochastic Linear programming.
Non-traditional optimization techniques: Multi-objective optimization - Lexicographic method, Goal programming method, Genetic algorithms, Simulated annealing, Neural Networks based Optimization.

References:
1. Operations Research- Principles and Practice by Ravindran, Phillips and Solberg, John Wiely
2. Introduction to Operations Research by Hiller and Lieberman, Mc Graw Hill
3. Engineering Optimization - Theory and Practice by Rao, S.S., New Age International (P) Ltd. Publishers.
4. Engineering Optimization By Kalyanmanai Deb, Prentice Hall of India, New Delhi.
5. Genetic Algorithms - In Search, Optimization and Machine Learning by David E. Goldberg, Addison-Wesley Longman (Singapore) Pvt. Ltd.

FIRST SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 105 Elective Subject– I
B) ADVANCED NUMERICAL METHODS

Periods per week : 4 Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs. Credits : 3

Algebraic equations:Systems of linear equations: Gauss Elimination method, pivoting techniques, Thomas algorithm for tridiagonal system – Jacobi, Gauss Seidel, SOR iteration methods - Systems of nonlinear equations: Fixed point iterations, Newton Method, Eigenvalue problems: power method, inverse power method, Faddeev – Leverrier Method.

Ordinary differential equationsRungeKutta Methods for system of IVPs, numerical stability, Adams-Bashforth multistep method, solution of stiff ODEs, shooting method, BVP: Finite difference method, orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method.

Finite difference method for time dependent partial differential equation parabolic equations: explicit and implicit finite difference methods, weighted average approximation - Dirichlet and Neumann conditions – Two dimensional parabolic equations – ADI method; First order hyperbolic equations – method of characteristics, different explicit and implicit methods; numerical stability analysis, method of lines – Wave equation: Explicit scheme- Stability of above schemes.

Finite difference methods for elliptic equations laplace and poisson's equations in a rectangular region: Five point finite difference schemes, Leibmann's iterative methods, Dirichlet and Neumann conditions – Laplace equation in polar coordinates: finite difference schemes – approximation of derivatives near a curved boundary while using a square mesh.

Finite element method partialdifferential equations – Finite element method - orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method.

References :

1. SaumyenGuha and Rajesh Srivastava, "Numerical methods for Engineering and Science", Oxford Higher Education, New Delhi, 2010.
2. Gupta S.K., "Numerical Methods for Engineers", New Age Publishers, 1995
3. Burden, R.L., and Faires, J.D., "Numerical Analysis – Theory and Applications", Cengage Learning, India Edition, New Delhi, 2009.
4. Jain M. K., Iyengar S. R., Kanchi M. B., Jain , "Computational Methods for Partial Differential Equations", New Age Publishers,1993.
5. Morton K.W. and Mayers D.F., "Numerical solution of partial differential equations", Cambridge University press, Cambridge, 2002.

FIRST SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 105 Elective Subject– I
C) ADVANCED TOOL DESIGN

Periods per week : 4 Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs. Credits : 3

Introduction to tool design Introduction –Tool Engineering – Tool Classifications– Tool Design Objectives – Tool Design in manufacturing- Challenges and requirements- Standards in tool design-Tool drawings -Surface finish – Fits and Tolerances - Tooling Materials- Ferrous and Non ferrous Tooling Materials- Carbides, Ceramics and Diamond -Non metallic tool materials- Designing with relation to heat treatment

Design of cutting tools Mechanics of Metal cutting –Oblique and orthogonal cutting- Chip formation and shear angle - Single-point cutting tools – Milling cutters – Hole making cutting tools- Broaching Tools - Design of Form relieved and profile relieved cutters-Design of gear and thread milling cutters

Design of jigs and fixtures Introduction – Fixed Gages – Gage Tolerances –selection of material for Gages – Indicating Gages – Automatic gages – Principles of location – Locating methods and devices – Principles of clamping – Drill jigs – Chip formation in drilling – General considerations in the design of drill jigs – Drill bushings – Methods of construction –Thrust and Turning Moments in drilling - Drill jigs and modern manufacturing- Types of Fixtures – Vise Fixtures – Milling Fixtures – Boring Fixtures – Broaching Fixtures – Lathe Fixtures – Grinding Fixtures – Modular Fixtures – Cutting Force Calculations.

Design of press tool dies Types of Dies –Method of Die operation–Clearance and cutting force calculations- Blanking and Piercing die design – Pilots – Strippers and pressure pads- Presswork materials – Strip layout – Short-run tooling for Piercing – Bending dies – Forming dies – Drawing dies-Design and drafting.

Tool design for CNC machine tools Introduction –Tooling requirements for Numerical control systems – Fixture design for CNC machine tools- Sub plate and tombstone fixtures-Universal fixtures– Cutting tools– Tool holding methods– Automatic tool changers and tool positioners – Tool presetting– General explanation of the Brown and Sharp machine.

PERIODS REFERENCES:
1. Cyrll Donaldson, George H.LeCain, V.C. Goold, “Tool Design”, Tata McGraw Hill Publishing Company Ltd., 2000.
2. E.G.Hoffman,” Jig and Fixture Design”, Thomson Asia Pvt Ltd, Singapore, 2004
3. PrakashHiralal Joshi, “Tooling data”, Wheeler Publishing, 2000
4. Venkataraman K., “Design of Jigs, Fixtures and Press tools”, TMH, 2005
5. Haslehurst M., “Manufacturing Technology”, the ELBS, 1978.

FIRST SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 105 Elective Subject – I
D) DESIGN FOR MANUFACTURING AND ASSEMBLY

Periods per week : 4 Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs. Credits : 3

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.

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. 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.

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.

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, and 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

FIRST SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 106 Elective Subject– II
A) DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS

Periods per week : 4 Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs. Credits : 3

Oil hydraulic systems and hydraulic actuators Hydraulic Power Generators – Selection and specification of pumps, pump characteristics. Linear and Rotary Actuators – selection, specification and characteristics.

Control and regulation elements Pressure - direction and flow control valves - relief valves, non-return and safety valves - actuation systems.

Hydraulic circuits Reciprocation, quick return, sequencing, synchronizing circuits - accumulator circuits - industrial circuits - press circuits - hydraulic milling machine - grinding, planning, copying, - forklift, earth mover circuits- design and selection of components - safety and emergency mandrels.

Pneumatic systems and circuits Pneumatic fundamentals - control elements, position and pressure sensing - logic circuits - switching circuits - fringe conditions modules and these integration - sequential circuits - cascade methods - mapping methods - step counter method - compound circuit design - combination circuit design.

Installation, maintenance and special circuits Pneumatic equipments- selection of components - design calculations – application -fault finding - hydro pneumatic circuits - use of microprocessors for sequencing - PLC, Low cost automation - Robotic circuits.

References :
1. Antony Espossito, “Fluid Power with Applications”, Prentice Hall, 1980.
2. Dudleyt, A. Pease and John J. Pippenger, “Basic fluid power”, Prentice Hall, 1987.
3. Andrew Parr, “Hydraulic and Pneumatics” (HB), Jaico Publishing House, 1999.
4. Bolton. W., “Pneumatic and Hydraulic Systems “, Butterworth –Heinemann, 1997.
5. K.ShanmugaSundaram, “Hydraulic and Pneumatic Controls: Understanding made Easy" S.Chand& Co Book publishers, New Delhi, 2006 (Reprint 2009).

FIRST SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 106 Elective Subjcet– II
B) ADVANCED DESIGN

Periods per week : 4 Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs. Credits : 3

Design philosophy: Design process, Problem formation, Introduction to product design, Various design models-Shigley model, Asimov model and Norton model, Need analysis, Strength considerations -standardization. Creativity, Creative techniques, Material selections, Notches and stress concentration, design for safety and Reliability

Failure theories: Static failure theories, Distortion energy theory, Maximum shear stress theory, Coulomb-Mohr's theory, Modified Mohr's theory, Fracture mechanics theory. Fatigue failure theories, Fatigue mechanisms, Fatigue failure models, Fatigue failure criteria, Methods to reduce fatigue, Design for fatigue, Modified Goodman Diagram, Gerber method, Soderberg line, Surface failure models. Lubrication, friction and wear
Product Design: Product strategies, Product value, Product planning, product specifications, concept generation, concept selection, concept testing.

Design for manufacturing: Forging design, Casting design, Design process for non metallic parts, Plastics, Rubber, Ceramic, Wood, Glass parts.

Economic factors influencing design: Economic analysis, Break-even analysis, Human engineering considerations, Ergonomics, Design of controls, Design of displays. Value engineering, Material and process selection in value engineering, Modern approaches in design.

References:

1. Product Design and Manufacturing by A.K. Chitale and R.C. Gupta, Prentice Hall.
2. Mechanical Engineering Design by Joseph Shigley and Mischke. Sixth edition, Tata McGraw Hill
3. Machine Design - An Integrated Approach by R.L. Norton, Prentice Hall.
4. Product design and development by Karl T. Ulrich and Steven D. Eppinger. Third edition, Tata McGraw Hill.

FIRST SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 106 Elective Subjcet– II
C) COMPETITIVE MANUFACTURING SYSTEMS

Periods per week : 4 Examination : 70 ; Sessionals : 30

Examination (Theory): 3hrs. Credits : 3

Manufacturing in a competitive environment Automation of manufacturing process - Numerical control - Adaptive control - material handling and movement - Industrial robots - Sensor technology - flexible fixtures - Design for assembly, disassembly and service.

Group technology & flexible manufacturing systems Part families - classification and coding - Production flow analysis - Machine cell design - Benefits. Components of FMS - Application work stations - Computer control and functions - Planning, scheduling and control of FMS - Scheduling - Knowledge based scheduling - Hierarchy of computer control - Supervisory computer.

Computer software, simulation and database of FMS System issues - Types of software - specification and selection - Trends - Application of simulation - software - Manufacturing data systems - data flow - CAD/CAM considerations - Planning FMS database.

Lean Manufacturing Origin of lean production system – Customer focus – Muda (waste) – Standards – 5S system – Total Productive Maintenance – standardized work –Man power reduction – Overall efficiency - Kaizen – Common layouts - Principles of JIT - Jidoka concept – Poka-Yoke (mistake proofing) - Worker Involvement– Quality circle activity – Kaizen training - Suggestion Programmes – Hoshin Planning System (systematic planning methodology) – Lean culture.

Just in time Characteristics of JIT - Pull method - quality -small lot sizes - work station loads - close supplier ties – flexible work force - line flow strategy - preventive maintenance - Kanban system - strategic implications - implementation issues - Lean manufacture.

Text books:
1. Groover M.P., “Automation, Production Systems and Computer Integrated Manufacturing ", Third Edition, Prentice-Hall, 2007.
2. Pascal Dennis, “Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System”, (Second edition), Productivity Press, New York, 2007.

References:
1. Jha, N.K. “Handbook of Flexible Manufacturing Systems ", Academic Press Inc., 1991.
2. Kalpkjian, “Manufacturing Engineering and Technology ", Addison-Wesley Publishing Co., 1995.
3. TaiichiOhno, Toyota, “Production System Beyond Large-Scale production Productivity Press (India) Pvt.Ltd. 1992.

FIRST SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 106 Elective Subject– II
D) DESIGN AND ANALYSIS OF EXPERIMENTS

Periods per week : 4 Examination : 70 ; Sessionals : 30

Examination (Theory): 3hrs. Credits : 3

Strategy of Experimentation, Typical applications of Experimental design, Basic Principles, Guidelines for Designing Experiments.

Concepts of random variable, probability, density function cumulative distribution function. Sample and population, Measure of Central tendency; Mean median and mode, Measures of Variability, Concept of confidence level. Statistical Distributions: Normal, Log Normal & Weibull distributions. Hypothesis testing, Probability plots, choice of sample size.

Classical Experiments: Factorial Experiments: Terminology: factors, levels, interactions, treatment combination, randomization, Two-level experimental designs for two factors and three factors. Three-level experimental designs for two factors and three factors, Factor effects, Factor interactions, Fractional factorial design, Saturated Designs, Central composite designs. Illustration through Numerical examples. Measures of variability, Ranking method, Column effect method & Plotting method, Analysis of variance (ANOVA) in Factorial Experiments: YATE's algorithm for ANOVA, Regression analysis, Mathematical models from experimental data.

Quality, Western and Taguchi's quality philosophy, elements of cost, Noise factors causes of variation. Quadratic loss function & variations of quadratic loss function. Robust Design: Steps in Robust Design: Parameter design and Tolerance Design. Reliability Improvement through experiments.

Types of Orthogonal Arrays, selection of standard orthogonal arrays, Linear graphs and Interaction assignment, Dummy level Technique, Compound factor method, Modification of linear graphs

Evaluation of sensitivity to noise. Signal to Noise ratios for static problems: Smaller-the-better type, Nominal-the –better-type, Larger-the-better type. Signal to Noise ratios for Dynamic problems

Parameter and tolerance design concepts, Taguchi's inner and outer arrays, parameter design strategy, tolerance design strategy.

Textbook:

1. Design and Analysis of Experiments, 5th edition, by D.C. Montgomery, John Wiley & Sons, New York, 2001
2. DESIGN AND ANALYSIS OF EXPERIMENTS, by R. PANNERSELVAM
3. Design and Analysis of Experiments by Douglas C. Montgomery

FIRST SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 107 CAD Lab-1

Periods per week : 3 Examination: 50 Sessionals : 50
Examination (Practicals): 3hrs Credits : 1.5

List of Experiments:

1. 2D and 3D modelling and assembly modelling using modelling packages using AutoCAD, Auto Desk Mechanical desktop,.

2. 2D and 3D modelling and assembly modelling using modelling packages using Pro-Engineer, ,CREO

3. 2D and 3D modelling and assembly modelling using modelling packages using IDEAS

FIRST SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 108 CAM Lab-1

Periods per week : 3 Examination: 50 Sessionals : 50
Examination (Practicals): 3hrs Credits : 1.5

List of Experiments:

Features and selection of CNC turning and milling centers. Practice in part programming and operation of CNC turning machines, subroutine techniques and use of cycles. 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

Surface generation, Tool selection, NC code generation and Tool path simulation for turning and milling operations using CAM packages like CATIA, Gibbs CAM, Master CAM.

SECOND SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 201 COMPUTER INTEGRATED MANUFACTURING

Periods per week : 4 Examination : 70 ; Sessionals : 30

Examination (Theory): 3hrs. Credits : 3

Introduction: Scope of computer integrated manufacturing, Product cycle, Production automation.

Group technology: Role of group technology in CAD/CAM integration, Methods for developing part families, Classification and coding, Examples of coding systems, Facility design using group technology, Economics of group technology.

Computer aided process planning: Approaches to process planning - Manual, Variant, Generative approach, Process planning systems - CAPP, DCLASS, CMPP, Criteria for selecting a CAPP system, Part feature recognition, Artificial intelligence in process planning.

Integrative manufacturing planning and control: Role of integrative manufacturing in CAD/CAM integration, Over view of production control - Forecasting, Master production schedule, Capacity planning, M.R.P., Order release, Shop-floor control, Quality assurance, Planning and control systems, Cellular manufacturing, JIT manufacturing philosophy.

Computer aided quality control: Terminology in quality control, Contact inspection methods, Noncontact inspection methods, Computer aided testing, Integration of CAQC with CAD/CAM.

Computer integrated manufacturing systems: Types of manufacturing systems, Machine tools and related equipment, Material handling systems, Computer control systems, FMS.

References:
1. CAD/CAM Principles and Applications by P.N. Rao, Tata McGraw Hill Publishing Company Ltd.
2. CAD/CAM Computer Aided Design and Manufacturing by Mikell P. Groover and Emory W. Zimmer, Jr.
3. Computer Integrated Design and Manufacturing by David D. Bedworth, Mark R.Henderson, Philip M. Wolfe.
4. Automation, Production Systems and Computer Integrated Manufacturing by Mikell P. Groover, Prentice Hall of India Pvt. Ltd.
5. Principles of Computer Integrated Manufacturing by Vajapayee, Prentice Hall of India Pvt. Ltd.

SECOND SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 202 MECHATRONICS

Periods per week : 4 Examination : 70 ; Sessionals : 30

Examination (Theory): 3hrs. Credits : 3

Mechatronics system design: Introduction to Mechatronics: What is mechatronics, Integrated design issues in mechatronics, Mechatronics key elements, the mechatronics design process, Advanced approaches in mechatronics.

Modelling and simulation of physical systems: Simulation and block diagrams, Analogies and impedance diagrams, Electrical systems, Mechanical translational systems, Mechanical rotational systems, Electromechanical coupling, Fluid systems.

Sensors and transducers: An introduction to sensors and transducers, Sensors for motion and position measurement, Force, torque and tactile sensors, Flow sensors, Temperature-sensing devices. Actuating devices: Direct current motor, Permanent magnet stepper motor, Fluid power actuation.

Signals, systems and controls: Introduction to signals, systems and controls, System representation, Linearization of nonlinear systems, Time delays.

Real time interfacing: Introduction, Elements of a data acquisition and control system, Overview of the I/O process, Installation of the I/O card and software.

Advanced applications in mechatronics: Sensors for condition monitoring, Mechatronic control in automated manufacturing, Artificial intelligence in mechatronics, Microsensors in mechatronics.

Text Books:

1. Mechatronics System Design by DevdasShetty and Richard A. Kolk, P.W.S. Publishing Company, 2001

References:

1. Mechatronics by W. Bolton, Pearson Education, Asia, II-Edition, 2001
2. Introduction to Mechatronics and Measurement Systems by Michael B. Histand and David G. Alciatore, Tata McGraw Hill Company Ltd.

SECOND SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 203 FLEXIBLE MANUFACTURING SYSTEMS

Periods per week : 4 Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs. Credits : 3

Introduction: The economic justification of FMS, The basic components of FMS and their integration in the data processing system, The concept of the 'total system'.

Management decisions during FMS project planning, design and implementation: Designing the FMS, Data processing design, FMS project and software documentation.

Artificial intelligence in the design of FMS: LISP, PROLOG, Expert systems, Expert systems in FMS design and control, Integrative aspects of AI languages.

Distributed processing in FMS: Introduction to database management systems (DBMS) and their application in CAD/CAM and FMS, Distributed systems in FMS.

Distributed tool data bases in FMS: The distributed tool data structure with a general purpose tool description facility, Implementation of the FMS tool data base, Application possibilities of the FMS tool data base.

FMS database for clamping devices and fixtures: The FMS clamping device and fixture data base, The analysis and calculation of pallet alignment and work mounting errors, Mating surface description methods for automated design and robotised assembly, Application of industrial robots in FMS, The application of automated guided vehicle (AGV) systems.

Coordinate measuring machines in computer integrated systems: Overview of coordinate measuring machine, Contact and non-contact inspection principles, Part programming coordinate measuring machines, In-cycle gauging.

References:
1. The Design and Operations of FMS by Dr. Paul Ranky, IFS (Publications) Ltd., UK, 1983.
2. Flexible Manufacturing Systems in Practice by Joseph Talavage and Roger G. Hannam, Marcel Dekker Inc., New York.
3. Robotics Technology and Flexible Automation by S.R. Deb, Tata McGraw Hill Company Ltd.

SECOND SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 204 VISION SYSTEMS AND IMAGE PROCESSING

Periods per week : 4 Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs. Credits : 3

Machine vision - Vision sensors - Comparison with other types of sensors - Image acquisition and recognition - Recognition of 3D objects - Lighting techniques - Machine vision applications.
Image representation - Application of image processing - Image sampling, Digitization and quantization - Image transforms.

Spatial domain techniques - Convolution, Correlation. Frequency domain operations - Fast Fourier transforms, FFT, DFT, Investigation of spectra. Hough transform

Image enhancement, Filtering, Restoration, Histogram equalisation, Segmentation, Region growing.

Image compression - Edge detection - Thresholding - Spatial smoothing - Boundary and Region representation - Shape features - Scene matching and detection - Image classification.

References:

1. Digital Image Processing by Gonzalez, R.C. and Woods, R.E., Addison Wesley Publications.
2 Robot Vision by Prof. Alan Pugh (Editor), IFS Ltd., U.K. 3. Digital Image Processing by A. Rosenfled and A. Kak, Academic Press.
4. The Psychology of Computer Vision by P. Winstan, McGraw-Hill.
5. Algorithms for Graphics and Image Processing by T. Pavidis, Springer Verlag.

SECOND SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 205 Elective Subject– III

A) ADVANCED FINITE ELEMENT ANALYSIS

Periods per week : 4 Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs. Credits : 3

Introduction, Finite elements of an elastic continuum - displacement approach, generalization of the finite element concept - weighted residuals and variational approaches. Plane stress and plane strain, Axisymmetric stress analysis, 3-D stress analysis.

Element shape functions - Some general families of C continuity, curved, isoparametric elements and numerical integration. Some applications of isoparametric elements in two-and-three dimensional stress analysis.

Bending of thin plates - A C continuity problem. Non-conforming elements, substitute shape functions, reduced integration and similar useful tricks. Lagrangian constraints in energy principles of elasticity, complete field and interface variables (Hybrid method).

Shells as an assembly of elements, axisymmetric shells, semi-analytical finite element processes - Use of orthogonal functions, shells as a special case of 3-D analysis. Steady-state field problems - Heat conduction, electric and magnetic potentials, field flow, etc.

The time domain, semi-descritization of field and dynamic problems and analytical solution procedures. Finite element approximation to initial value - Transient problems.

References:

1. The Finite Element Method by O.C. Zienkiewicz, Tata McGraw Hill Company Ltd.
2. The Finite Element Methods in Engineering by Rao, S.S.
3. Concepts and Applications of Finite Element Analysis by Cook, R.D.
4. Applied Finite Element Analysis by Segerland, L.J.

SECOND SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 205 Elective Subject– III
B) NEURAL NETWORKS AND FUZZY TECHNIQUES

Periods per week : 4 Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs. Credits : 3

Neural networks and fuzzy systems: Nerual and fuzzy machine intelligence, Fuzzy as multivalence, The dynamical - Systems approach to machine intelligence, Intelligent behaviour as adaptive model - Free estimation.

Neural dynamics-I: Activations and signals, Neurons as functions, Signal monotonicity, Biological activations and signals, Neuron fields, Neuronal dynamical systems, Common signal functions, Pulse-coded signal functions.

Neuronal dynamics-II: Activation models, Neuronal dynamical systems, Additive neuronal dynamics, Additive neuronal feedback, Additive bivalent models, BAM connection matrices, Additive dynamic and the noise - Saturation dilemma, General neuronal Activations: Cohen-Grossberg and multiplicative models. Synaptic Dynamics I: Unsupervised learning, Learning as encoding, change, and quantization, Four unsupervised learning laws, Probability spaces and random processes, Stochastic unsupervised learning and stochastic equilibrium, Signal Hebbian learning, Competitive learning, Differential Hebbian learning, Differential competitive leering.

Synaptic Dynamics II: Supervised learning, Supervised function estimation, Supervised learning as operant conditioning, Supervised learning as stochastic pattern learning with known class memberships, Supervised learning as stochastic approximation, The back propagation algorithm. Fuzziness Versus: Probability fuzzy sets and systems, Fuzziness in a probabilistic world, Randomness vs. ambiguity: Whether vs. how much, The universe as a fuzzy set, The geometry of fuzzy set, The geometry of fuzzy sets: Sets as points. The fuzzy entropy theorem, Thesubsethood theorem. The entropy-subsethood theorem.

Fuzzy associative memories: Fuzzy systems as between-cube mappings, Fuzzy and neural function estimators, Fuzzy Hebb FAMs, Adaptive FAMs: Product-space clustering in FAM cells. Applications in design and structural analysis.

References:

1. Neural Networks & Fuzzy Systems by Bark Kosko, PHI Published in 1994
2. Neural Network Fundamentals with Graphs, Algorithms and Applications by B.K. Bose, Tata-McGraw Hill.
3. Neural network Design by Hagan, Demuth and Beale, Vikas Publishing House.
4. Fundamentals of Artificial Neural Networks by Mohamad H Hassoum. PHI.
5. Fuzzy Set Theory & its Application by .J. Zimmerman Allied Published Ltd.
6. Algorithms and Applications of Neural Networks in Mechanical Engineering by M. AnandaRao and J. Srinivas, Narosa Publishing House.

SECOND SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 205 Elective Subject– III
C) CONCURRENT ENGINEERING

Periods per week : 4 Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs. Credits : 3

Introduction: Concurrent design of products and systems - Product design - Fabrication and assembly system design - designing production systems for robustness and structure.

Strategic approach and technical aspects of product design: Steps in the strategic approach to product design - Comparison to other product design methods - Assembly sequence generation - Choosing a good assembly sequence - Tolerances and their relation to assembly - Design for material handling and part mating - Creation and evaluation of testing strategies.

Basic issues in manufacturing system design: System design procedure - Design factors - Intangibles - Assembly resource alternatives - Task assignment - Tools and tool changing - Part feeding alternatives - Material handling alternatives - Floor layout and system architecture alternatives.

Assembly workstation design: Strategic issues - Technical issues analysis.

Design of automated fabrication systems: Objectives of modern fabrication system design - System design methodology - Preliminary system feasibility study - Perform detailed work content analysis - Define alternative fabrication configurations - Configuration design and layout - Human resource considerations - Evaluate technical performance of solution.

Case studies: Automobile air conditioning module - Robot assembly of automobile rear axles.

Reference:

1. Concurrent Design of Product and Processes by James L. Nevins and Daniel E. Whitney, McGraw-Hill Publishing Company, 1989.

SECOND SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 205 Elective Subject- III

D) MODELING AND SIMULATION OF MANUFACTURING SYSTEMS

Periods per week : 4 Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs. Credits : 3

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

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

Random numbers: Need for RNs, Technique for Random number generation such as Mid product method, Mid square method, and Linear congruential method with examples Test for Random numbers: Uniformity - Chi square test or Kolmogorov Smirnov test, Independency- Auto correlation test Random Variate generation: Technique for Random variate generation such as Inverse transforms technique or Rejection method

Analysis of simulation data: Input data analysis, Verification and validation of simulation models, Output data analysis Simulation languages: History of simulation languages, Comparison and selection of simulation languages Design and evaluation of simulation experiments: Development and analysis of simulation models using simulation language with different manufacturing systems Queueing models: An introduction, M/M/1 and M/M/m Models with examples, Open Queueing and Closed queueing network with examples Markov chain models and others: Discrete time markov chain with examples, Continues time markov chain with examples, stochastic process in manufacturing, Game theory

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

SECOND SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 205 Elective Subject - III
E) RELIABILITY ENGINEERING

Periods per week : 4 Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs. Credits : 3

Introduction: Concepts of quality and reliability, a brief history, terms, definitions, reliability function, MTTF, Hazard rate function, bath tub curve, conditional reliability.

Constant failure rate models: Exponential reliability, failure modes, failure modes with exponential distribution, applications, two parameter exponential distribution, Poisson process.

Time dependent failure models: Weibull distribution, burn-in screening for Weibull, three parameter Weibull distribution, Normal and Lognormal distributions

Reliability of systems: Series, parallel configurations, combined systems, k-out-of-n systems, complex configurations, common failure modes, minimal cuts and minimal paths.

State dependent systems: Markov analysis, load sharing, standby systems, degraded systems

Physical reliability models: Static models- random stress and random strength, dynamic models-periodic models, random loads.

Design for reliability: Reliability specification, Lifecycle costs, reliability allocation, design methods, failure analysis, FTA.

Reliability testing: Life testing, burn-in testing, acceptance testing-binomial acceptance testing.

Reliability growth testing: Reliability growth process, idealized growth curve, Duane growth model.

Text Book:

Introduction to Reliability and Maintenance engineering by Charles E Ebeling, Tata McGrawhill, India.

References:

Introduction to Reliability Engineering by E.E. Lewis, John Wiley& Sons, NewYork

Reliability based design by S.S.Rao, McGraw-Hill, New York

SECOND SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 206 CAD Lab-2

Periods per week : 3 Examination: 50 Sessionals : 50
Examination (Practicals): 3hrs Credits : 1.5

List of Experiments:

1. Linear and non-linear static and dynamic analysis using any FEA package ANSYS /
2. Linear and non-linear static and dynamic analysis using any FEA package CAEFEM.
3. Linear and non-linear static and dynamic analysis using any FEA package NASTRAN.
4. 1D, 2D and 3D Meshing, Linear and non-linear static and dynamic analysis using any one FEA packages like ANSYS/CAEFEM/NASTRAN/NISA.

SECOND SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 207 CAM Lab-2

Periods per week : 3 Examination: 50 Sessionals : 50
Examination (Practicals): 3hrs Credits : 1.5

List of Experiments:

Practice in Robot programming and its languages. Robotic simulation using software. Robo path control, preparation of various reports and route sheets, Simulation of manufacturing system using CAM software, controller operating system commands.

SECOND SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 208 SEMINAR

Periods per week : 3 Examination: 50 Sessionals : 50
Credits : 1

A student has to give seminar on the topics related to his specialization.

THIRD SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 301 Elective Subject- IV
A) SIGNAL ANALYSIS AND CONDITION MONITORING

Periods per week : 4 Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs. Credits : 3

Introduction: Basic concepts. Fourier analysis. Bandwidth. Signal types. Convolution.

Signal analysis: Filter response time. Detectors. Recorders. Analog analyzer types.

Practical analysis of stationary signals: Stepped filter analysis. Swept filter analysis. High speed analysis. Real-time analysis.

Practical analysis of continuous non-stationary signals: Choice of window type. Choice of window length. Choice of incremental step. Practical details. Scaling of the results.

Practical analysis of transients: Analysis as a periodic signal. Analysis by repeated playback (constant bandwidth).Analysis by repeated playback (variable bandwidth).

Condition monitoring in real systems: Diagnostic tools. Condition monitoring of two stage compressor. Cement mill foundation. I.D. fan. Sugar centrifugal. Cooling tower fan. Air separator. Preheater fan. Field balancing of rotors. ISO standards on vibrations.

References:

1. Condition Monitoring of Mechanical Systems by Kolacat.
2. Frequency Analysis by R.B.Randall.
3. Mechanical Vibrations Practice with Basic Theory by V. Ramamurti, Narosa Publishing House.

THIRD SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 301 Elective Subject- IV

B) COMPUTATIONAL FLUID DYNAMICS

Periods per week : 4 Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs. Credits : 3

Classification of partial differential equations - Discretization methods - finite difference and finite volume formulations –classification of PDES.
An overview of finite difference, finite element and finite volume methods. Numerical solution of parabolic partial differential equations using finite-difference and finite volume methods: explicit and implicit schemes, consistency, stability and convergence.
Numerical solution of systems of linear algebraic equations: general concepts of elimination and iterative methods, Gaussian elimination, Jacobi and Gauss-Seidel iterations, necessary and sufficient conditions for convergence of iterative schemes.
The finite volume method of discretization for diffusion problems: one dimensional steady diffusion problems, specification of interface diffusivity, source-term linearization. Discretization of transient one-dimensional diffusion problems. Solution of discretized equations using point and line iterations, strongly implicit methods and pre-conditioned conjugate gradient methods.
Numerical solution of the Navier-Stokes system for incompressible flows: stream-function vorticity and artificial compressibility methods.
Basics of grid generation- Numerical solution of hyperbolic equations - Burgers equation generation.
Reference books:

1. Tannehill, J.c., Anderson, D.A., and Pletcher, R.H., Computational Fluid Mechanics and Heat Tran5fer, 2nd ed., Taylor & Francis, 1997.
2. Numerical heat transfer and fluid flow – S.V. Patankar (Hemisphere Pub. House)
3. An Introduction to Computational Fluid Dynamics – FVM Method – H.K. Versteeg, W. Malalasekhara (PHI)
4. Peyret, R. and Taylor, T. D., Computational Methods for Fluid Flow, Springer- Verlag, 1983.
5. Computational Fluid Dynamics – Hoffman and Chiang, Engg Education System
6. Computational Fluid Dynamics – Anderson (TMH)
7. Computational Methods for Fluid Dynamics – Ferziger, Peric (Springer)
8. Computational Fluid Dynamics, T.J. Chung, Cambridge University
9. Computaional Fluid Dynamics – A Practical Approach – Tu, Yeoh, Liu (Elsevier)
   Text Book of Fluid Dynamics, Frank Chorlton, CBS Publishers.

THIRD SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 301 Elective Subject - IV
C) METROLOGY AND NON DESTRUCTIVE TESTING

Periods per week : 4 Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs. Credits : 3

Measuring machines Tool Maker's microscope - Co-ordinate measuring machines - Universal measuring machine - Laser viewers for production profile checks - Image shearing microscope - Use of computers - Machine vision technology - Microprocessors in metrology.

Statistical Quality Control Data presentation - Statistical measures and tools - Process capability - Confidence and tolerance limits - Control charts for variables and for fraction defectives - Theory of probability - Sampling - ABC standard - Reliability and life testing.

Liquid penetrant and magnetic particle tests Characteristics of liquid Penetrants - different washable systems - Developers - applications - Methods of production of magnetic fields - Principles of operation of magnetic particle test - Applications - Advantages and limitations.
RADIO GRAPHY Sources of ray-x-ray production - properties of d and x rays - film characteristics - exposure charts - contrasts - operational characteristics of x ray equipment - applications.

Ultrasonic and acoustic emission techniques Production of ultrasonic waves - different types of waves - general characteristics of waves - pulse echo method - A, B, C scans - Principles of acoustic emission techniques - Advantages and limitations - Instrumentation - applications.

References:
1. JAIN, R.K. “Engineering Metrology ", Khanna Publishers, 1997.
2. Barry Hull and Vernon John, " Non Destructive Testing ", Mac Millan, 1988.
3. American Society for Metals, “Metals Hand Book ", Vol. II, 1976.
4. Progress in Acoustic Emission, “Proceedings of 10th International Acoustic Emission Symposium ", Japanese Society for NDI, 1990.

THIRD SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 302 ADDITIVE MANUFACTURING

Periods per week : 4 Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs. Credits : 3

Introduction: Need - Development of AM systems – AM process chain - Impact of AM on Product Development - Virtual Prototyping- Rapid Tooling – RP to AM -Classification of AM processes- Benefits- Applications.

Reverse engineering and cad modeling: Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modeling techniques: Wire frame, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation-Software for AM- Case studies.

Liquid based and solid based additive manufacturing systems: Stereolithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications. Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and applications. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

Powder based additive manufacturing systems: Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies.

Other additive manufacturing systems: Three dimensional Printing (3DP): Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing (SDM), Ballastic Particle Manufacturing (BPM), Selective Laser Melting, Electron Beam Melting.

References:
1. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
2. Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", second edition, World Scientific Publishers, 2010.
3. Gebhardt, A., "Rapid prototyping", Hanser Gardener Publications, 2003.
4. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications : A tool box for prototype development", CRC Press, 2011.
5. Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
6. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.

THIRD SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 303 INTERNAL ASSESSMENT OF PROJECT

Periods per week :3 Viva : 100
Credits : 10

A student has to submit his proposal for his Project work, which includes the area of interest coupled with literature survey.

FOURTH SEMESTER WITH EFFECT FROM 2019-20
MTCAD&CAM 401

Viva : 100
Credits : 16

A student has to submit and defend his work in the presence of Expert Committee which includes external Examiner