# COURSE STRUCTURE AND SYLLABUS

For

# M.Tech

## CAD/CAM

(*Applicable for batches admitted from 2016-17*)

# PRAGATI ENGINEERING COLLEGE

**(AUTONOMOUS)**

Permanently Affiliated to JNTUK, Kakinada, Accredited by NAAC with "A" Grade
Recognized by UGC 2(f) and 12(b) under UGC act, 1956
# 1-378, ADB Road, Surampalem – 533 437
Near Peddapuram, E.G.Dist, Andhra Pradesh

**PRAGATI ENGINEERING COLLEGE : SURAMPALEM**
**(Autonomous)**

## I Semester

| S.No. | Subject Code | Subject | L | P | C |
|---|---|---|---|---|---|
| 1 | 16061T01 | Industrial Robotics | 4 | - | 3 |
| 2 | 16061T02 | Computer Aided Manufacturing | 4 | - | 3 |
| 3 | 16061T03 | Special Manufacturing Processes | 4 | | 3 |
| 4 | 16061T04 | Geometric Modeling | 4 | - | 3 |
| 5 | **Elective I** | | 4 | - | 3 |
| | 16061D01 | Computational Methods in Engineering | | | |
| | 16061D02 | Mechanical Vibrations | | | |
| | 16061D03 | Nano Technology | | | |
| 6 | **Elective II** | | 4 | - | 3 |
| | 16061D04 | Design for Manufacturing | | | |
| | 16061D05 | Mechatronics | | | |
| | 16061D06 | Computer Aided Process Planning | | | |
| 7 | 16061L01 | Advanced CAD Lab | - | 3 | 2 |
| **Total Credits** | | | | | **20** |

## II Semester

| S.No. | Subject Code | Subject | L | P | C |
|---|---|---|---|---|---|
| 1 | 16062T05 | Simulation Modeling of Manufacturing Systems | 4 | - | 3 |
| 2 | 16062T06 | Optimization and Reliability | 4 | - | 3 |
| 3 | 16062T07 | Computer Graphics | 4 | | 3 |
| 4 | 16062T08 | Advanced Finite Element Method | 4 | - | 3 |
| 5 | **Elective III** | | | - | 3 |
| | 16062D07 | Quality Engineering in Manufacturing | | | |
| | 16062D08 | Fracture Mechanics | | | |
| | 16062D09 | Concurrent Engineering | | | |
| 6 | **Elective IV** | | | - | 3 |
| | 16062D10 | Mechanics And Manufacturing Methods of Composites | | | |
| | 16062D11 | Materials Technology | | | |
| | 16062D12 | Intelligent Manufacturing Systems | | | |
| 7 | 16062L02 | Modeling and Analysis of Manufacturing Processes Lab | - | 6 | 4 |
| **Total Credits** | | | | | **22** |

## III Semester

| S.No. | Subject Code | Subject | L | P | C |
|---|---|---|---|---|---|
| 1 | 16063P01 | Comprehensive Viva | - | - | 2 |
| 2 | 16063S01 | Seminar-I | - | - | 2 |
| 3 | --- | Project Work Part – I | - | - | 14 |
| **Total Credits** | | | **-** | **-** | **18** |

## IV Semester

| S.No. | Subject Code | Subject | L | P | C |
|---|---|---|---|---|---|
| 1 | 16064S02 | Seminar-II | - | - | 2 |
| 2 | 16064P02 | Project Work Part – II | - | - | 18 |
| **Total Credits** | | | **-** | **-** | **20** |

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**M.Tech (CAD/CAM)**

| **I Year – I SEMESTER** | **L** | **P** | **C** |
|---|---|---|---|
| | **4** | **0** | **3** |

## INDUSTRIAL ROBOTICS

**UNIT - I**

**INTRODUCTION**: Automation and Robotics, Robot anatomy, robotconfiguration, motions, joint notation, work volume, robot drive system, control system and dynamic performance, precision of movement.

**CONTROL SYSTEM AND COMPONENTS:** Basic concept and modelscontrollers, control system analysis, robot activation and feedback components. Positions sensors, velocity sensors, actuators sensors, power transmission system.

**UNIT - II**

**MOTION ANALYSIS AND CONTROL:** Manipulator kinematics,position representation, forward transformation, homogeneous transformation, manipulator path control, robot dynamics, configuration of robot controller.

**UNIT - III**

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

**MACHINE VISION:** Functions, Sensing and Digitizing-imaging,Devices, Lighting techniques, Analog to digital signal conversion, image storage, Image processing and Analysis-image data reduction, Segmentation feature extraction. Object recognition, training the vision system, Robotics application.

**UNIT - IV**

**ROBOT PROGRAMMING:** Lead through programming, Robotprogramming as a path in space, Motion interpolation, WAIT, SINONAL AND DELAY commands, Branching capabilities and Limitations.

**ROBOT LANGUAGES**: Textual robot Languages, Generation, Robotlanguage structures, Elements in function.

**UNIT - V**

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

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

**TEXT BOOKS:**

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

**REFERENCES:**

1. Robotics / Fu K S/ McGraw Hill.
2. Robotic Engineering / Richard D. Klafter, Prentice Hall
3. Robot Analysis and Intelligence / Asada and Slotine / Wiley Inter-Science.
4. Robot Dynamics & Control – Mark W. Spong and M. Vidyasagar / John Wiley
5. Introduction to Robotics by SK Saha, The McGrah Hill Company, 6th, 2012
6. Robotics and Control / Mittal R K &Nagrath I J / TMH
7. http://nptel.ac.in/courses/112103174/39
8. http://nptel.ac.in/courses/112103174/40
9. http://nptel.ac.in/downloads/112101098/#

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## COMPUTER AIDED MANUFACTURING

**UNIT - I**

**COMPUTER AIDED PROGRAMMING**: General information, APTprogramming, Examples APT programming problems (2D machining only). NC programming on CAD/CAM systems, the design and implementation of post processors .Introduction to CAD/CAM software, Automatic Tool Path generation.

**UNIT - II**

**TOOLING FOR CNC MACHINES:** Interchangeable tooling system,preset and qualified tools, coolant fed tooling system, modular fixturing, quick change tooling system, automatic head changers. DNC Systems and Adaptive Control: Introduction, type of DNC systems, advantages and disadvantages of DNC, adaptive control with optimization, Adaptive control with constraints, Adaptive control of machining processes like turning, grinding.

**UNIT - III**

**POST PROCESSORS FOR CNC:** Introduction to Post Processors:The necessity of a Post Processor, the general structure of a Post Processor, the functions of a Post Processor, DAPP — based- Post Processor: Communication channels and major variables in the DAPP
— based Post Processor, th creation of a DAPP — Based Post Processor.

**UNIT - IV**

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

**UNIT - V**

**COMPUTER AIDED PROCESS PLANNING**: Hybrid CAAP System,Computer Aided Inspection and quality control, Coordinate Measuring Machine, Limitations of CMM, Computer Aided Testing, Optical Inspection Methods, Artificial Intelligence and expert system: Artificial Neural Networks, Artificial Intelligence in CAD, Experts systems and its structures.

**TEXT BOOKS:**

1. Computer Control of Manufacturing Systems / YoramKoren / Mc Graw Hill. 1983.
2. CAD/CAM Principles and Applications, P.N.Rao, TMH

**REFERENCES:**

1. Computer Aided Design Manufacturing – K. Lalit Narayan, K. Mallikarjuna Rao and M.M.M. Sarcar, PHI, 2008.
2. CAD / CAM Theory and Practice,/ Ibrahim Zeid,TMH
3. CAD / CAM / CIM, Radhakrishnan and Subramanian, New Age
4. Principles of Computer Aided Design and Manufacturing, FaridAmirouche, Pearson
5. Computer Numerical Control Concepts and programming, Warren S Seames, Thomson.
6. http://nptel.ac.in/video.php?subjectId=112102101
7. http://nptel.ac.in/courses/Webcourse-contents/IIT-Delhi/Computer%20Aided%20Design%20&%20ManufacturingI/index.htm
8. http://www.nptelvideos.in/2012/12/computer-aided-design.html

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## SPECIAL MANUFACTURING PROCESSES

**UNIT- I**

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

**UNIT- II**

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

**UNIT- III**

**FABRICATION OF MICROELECTRONIC DEVICES**:

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

**UNIT - IV**

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

**UNIT -V**

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

**TEXT BOOKS:**


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

**REFERENCES:**

1 Microelectronic packaging handbook / Rao. R. Thummala and Eugene, J. Rymaszewski / Van NostrandRenihold,

2 MEMS & Micro Systems Design and manufacture / Tai — Run Hsu / TMGH

3 Advanced Machining Processes / V.K.Jain / Allied Publications.

4. Introduction to Manufacturing Processes / John A Schey*I* Mc Graw Hill.

5.http://nptel.ac.in/courses/112107145/7

6.http://nptel.ac.in/courses/112105126/

7.http://nptel.ac.in/courses/112107144/27

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## GEOMETRIC MODELING

**UNIT - I**

**Introduction:** Definition, Explicit and implicit equations, parametricequations.

**UNIT - II**

**Cubic Splines-1:** Algebraic and geometric form of cubic spline, tangentvectors, parametric space of a curve, blending functions, four point form, reparametrization, truncating and subdividing of curves. Graphic construction and interpretation, composite pc curves.

**UNIT - III**

**Bezier Curves:** Bernstein basis, equations of Bezier curves, properties,derivatives.

**B-Spline Curves:** B-Spline basis, equations, knot vectors, properties,and derivatives.

**UNIT – IV**

**Surfaces:** Bicubic surfaces, Coon's surfaces, Bezier surfaces, B-Splinesurfaces, 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, Halfspace modeling, spatial cell, cell decomposition, classification problem.

**TEXT BOOKS:**


1. CAD/CAM by Ibrahim Zeid, Tata McGraw Hill.
2. Elements of Computer Graphics by Roger & Adams Tata McGraw Hill.


**REFERENCES:**


1. Geometric Modeling by Micheal E. Mortenson, McGraw Hill Publishers
2. Computer Aided Design and Manufacturing, K.Lalit Narayan, K.Mallikarjuna Rao, MMM Sarcar, PHI Publishers
3. http://nptel.ac.in/courses/112102101/44
4. http://nptel.ac.in/courses/112106061/Module_2/Lecture_2.1.pdf

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## COMPUTATIONAL METHODS IN ENGINEERING
## (ELECTIVE I)

**UNIT – I**

**Introduction to numerical methods applied to engineering problems:**
Examples, solving sets of equations – Matrix notation – Determinants and inversion – Iterative methods – Relaxation methods – System of non-linear equations. Least square approximation fitting of non-linear curves by least squares –regression analysis- multiple linear regression, non linear regression - computer programs.

**UNIT – II**

**Boundry value problems and charecteristic value problems:** Shootingmethod – Solution through a set of equations – Derivative boundary conditions – Rayleigh – Ritz method – Characteristic value problems.

**UNIT – III**

**Transformation Techniques:** Continuous fourier series, frequencyand time domains, laplace transform, fourier integral and transform, discrete fourier transform (DFT), Fast fourier transform (FFT).

**UNIT – IV**

**Numerical solutions of partial differential equations:** Laplace'sequations – 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.

**UNIT – V**

**Partial differential equations:** Explicit method – Crank-Nickelsonmethod – Derivative boundary condition – Stability and convergence criteria. Solving wave equation by finite differences-stability of numerical method –method of characteristics-wave equation in two space dimensions-computer programs.

**TEXT BOOKS:**


1. Steven C.Chapra, Raymond P.Canale "Numerical Methods for Engineers" Tata Mc-Graw Hill
2. Curtis F.Gerald, Partick.O.Wheatly,"Applied numerical analysis"Addison-Wesley,1989
3. Douglas J.Faires,RichedBurden"Numerical methods", Brooks/Cole publishing company,1998.Second edition.

**REFERENCES:**

1. Ward Cheney and David Kincaid "Numerical mathematics and computing" Brooks/Cole publishing company1999, Fourth edition.
2. Riley K.F,.M.P.Hobson and BenceS.J,"Mathematical methods for physics and engineering", Cambridge University press,1999.
3. Kreysis, Advanced Mathematics
4. http://nptel.ac.in/courses/103106074/

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## MECHANICAL VIBRATIONS
## (ELECTIVE I)

**UNIT- I**

**Single degree of Freedom systems:** Undamped and damped freevibrations: forced vibrations ; coulomb damping; Response to harmonic excitation; rotating unbalance and support excitation, Vibration isolation and transmissibility. Response to Non Periodic Excitations: unit Impulse, unit step and unit Ramp functions; response to arbitrary excitations, The Convolution Integral; shock spectrum; System response by the Laplace Transformation method.

**UNIT- II**

**Multi degree freedom systems:** Principal modes – undamped anddamped free and forced vibrations ; undamped vibration absorbers, Matrix formulation, stiffness and flexibility influence coefficients; Eigen value problem; normal modes and their properties; Free and forced vibration by Modal analysis; Method of matrix inversion; Torsional vibrations of multi – rotor systems and geared systems; Discrete-Time systems.

**UNIT- III**

**Numerical Methods:** Rayliegh's, stodola's, Matrix iteration, Rayleigh-Ritz Method and Holzer's methods

**UNIT- IV**

**Experimental Methods**: Vibrometers, velocity meters & accelerometers

**UNIT- V**

**Application of concepts:** Free vibration of strings–longitudinaloscillations of bars-transverse vibrations of beams- Torsional vibrations of shafts. Critical speeds without and with damping, secondary critical speed.

**TEXT BOOKS:**

1. Elements of Vibration Analysis by Meirovitch.
2. Mechanical Vibrations by G.K. Groover.

**REFERENCES:**

1. Vibrations by W.T. Thomson
2. Mechanical Vibrations – Schaum series.
3. Vibration problems in Engineering by S.P. Timoshenko.
4. Mechanical ViabrationsV.Ram Murthy.
5. http://www.nptelvideos.in/2012/12/mechanical-vibrations.html

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**NANO TECHNOLOGY**
**(ELECTIVE I)**

**UNIT-I :**

Introduction

Size and shape dependence of material properties at the nanoscale, why is small good?, limits to smallness, scaling relations, can nanorobots walk and nanoplanes fly? Nanoscale elements in conventional technologies, Mechanics at nanoscale, Enhancement of mechanical properties with decreasing size, Nanoelectromechanical systems, nanomachines,Nanofluidics, filtration, sorting,Molecular motors.

**UNIT-II**

Top-down and bottom-up nanofabrication, The Intel-IBM approach to nanotechnology: lithography, etching, ion implantation, thin film deposition, Electron beam lithography, Soft lithography: nanoimprinting and microcontact printing, Solution/plasma-phase nanofabrication, sol-gel methods, template techniques.

**UNIT-III**

Imaging/characterization of nanostructures, General considerations for imaging,Scanning probe techniques: SEM, STM, AFM, NSOM.

**UNIT-IV**

Metal and semiconductor nanoparticles, Synthesis, stability, control of size,Optical and electronic properties,Ultra-sensitive imaging and detection with nanoparticles, bioengineering applications,Catalysis. Semiconductor and metal nanowires Vapor/liquid/solid growth and other synthesis techniques, Nanowire transistors and sensors.

**UNIT-V**

**Carbon nanotubes**

Structure and synthesis,Electronic, vibrational, and mechanical properties, How can C nanotubes enable faster computers, brighter TV screens, and stronger mechanical reinforcement?

**TEXT BOOKS:**


1. Nanoscale Science and Technology by Kelsall, Hamley, and Geoghegan, Wiley (2005)
2. Introduction to Nanoscale Science and Technology by Di Ventra, Evoy, and Heflin, Kluwer Academic Publishers (2004).

**REFERENCES:**

1. Introduction to Nanotechnology by Poole and Owens, Wiley (2003)
2. Nanochemistry: A Chemical Approach to Nanomaterials, Ozin and Arsenault, RSC Publishing (2006).
3. http://nptel.ac.in/courses/118102003/
4. http://nptel.ac.in/courses/118104008/

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**I Year – I SEMESTER**

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## DESIGN FOR MANUFACTURING
## (ELECTIVE II)

**UNIT - I**

**Introduction:** Design philosophy-steps in design process-generaldesign rules for manufacturability-basic principles of designing for economical production-creativity in design.

**UNIT - II**

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

**UNIT - III**

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

**UNIT - IV**

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

**UNIT – V**

**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 guidelinesfor 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. Design for Manufacture by Boothroyd,

3. Design for manufacture, James Bralla

**REFERENCE:**

1. ASM Hand book Vol.20
2. http://nptel.ac.in/downloads/112101005/
3. http://nptel.ac.in/courses/107103012/
4. http://nptel.ac.in/courses/112101005/

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## MECHATRONICS
## (ELECTIVE II)

**UNIT-I**

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

**UNIT-II**

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

**UNIT-III**

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

Mechanical actuating systems and electrical actuating systems.

**UNIT-IV**

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

**UNIT-V**

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

**TEXT BOOKS:**


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

**REFERENCES:**

1 Mechatronics Source Book by Newton C Braga, Thomson Publications, Chennai.

2 Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.

3 Mechatronics System Design / Devdasshetty/Richard/Thomson.

4 Mechatronics/M.D.Singh/J.G.Joshi/PHI.

5 Mechatronics – Electronic Control Systems in Mechanical and Electrical Engg. 4th Edition, Pearson, 2012 W. Bolton

6 Mechatronics – Principles and Application Godfrey C. Onwubolu, Wlsevier, 2006 Indian print

7. http://nptel.ac.in/courses/112103174/

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## COMPUTER AIDED PROCESS PLANNING
## (ELECTIVE II)

**UNIT - I**

**Introduction to CAPP:** Information requirement for process planningsystem, 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 CAPPsystem, 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, alternativemanufacturing processes, reduction of total set-up cost for a particular sequence, quantitative methods for optimal selection, examples.

**Determination of machining parameters:** reasons for optimal selectionof 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.

**UNIT –V**

**Generation of tool path:** Simulation of machining processes, NC toolpath generation, graphical implementation, determination of optimal index positions for executing fixed sequence, quantitative methods.

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

**TEXT BOOK:**

1. Computer Aided Process Planning – Joseph Tulkoff, SME Publications
2. Computer Aided Process Planning – Hsu-Pin Wang, Jian-Kang Li, Elsevier

**REFERENCES:**

1. Automation , Production systems and Computer Integrated Manufacturing System – MikellP.Groover
2. Computer Aided Design and Manufacturing – Dr.Sadhu Singh.
3. Computer Aided Engineering – David Bedworth

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## ADVANCED CAD LAB

Students shall carry out the modeling and FE analysis of the following to predict deflection and stress distributions :

1. Trussess – 2D and 3D
2. Beams
3. Plate with Plane stress condition
4. Plate with Plane strain condition
5. Cylinders – Axi-symmetric condition
6. Natural frequencies of Beam

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## SIMULATION MODELING OF MANUFACTURING SYSTEMS

**UNIT - I**

System - ways to analyze the system - Model - types of models - Simulation - Definition - Types of simulation models - steps involved in simulation - Advantages & Disadvantages. Parameter estimation - estimator - properties - estimate - point estimate - confidence interval estimates - independent - dependent - hypothesis - types of hypothesis-step - types l& 2 errors - Framing - string law of large numbers.

**UNIT - II**

Building of Simulation model validation - verification - credibility - their timing - principles of valid simulation Modeling - Techniques for verification - statistical procedures for developing credible model. Modeling of stochastic input elements - importance - various procedures - theoretical distribution - continuous - discrete their suitability in modeling.

**UNIT - III**

Generation of random variables - factors for selection methods - inverse transform - composition - convolution - acceptance - rejection - generation of random variables - exponential - uniform - weibull - normal Bernoullie - Binomial uniform - poisson - Simulation languages - comparison of simulation languages with general purpose languages Simulation languages vs Simulators - software features - statistical capabilities - G P S S - S1MAN- SIMSCRIPT - Simulation of WMJI queue - comparison of simulation languages.

**UNIT - IV**

Output data analysis - Types of Simulation w. r. t output data analysis
– warm up period- Welch algorithm - Approaches for Steady - State Analysis - replication - Batch means methods - corn pan Sons.

**UNIT - V**

Applications of Simulation - flow shop system - job shop system - M/ MI1 queues with infinite and finite capacities - Simple fixed period inventory system – New boy paper problem.

**TEXT BOOKS:**

1. Simulation Modelling and Analysis / Law, A.M.& Kelton / Mc Graw Hill, Edition/ New York, 1991.
2. Simulation of Manufacturing Systems / Carrie A. / Wiley, NY, 1990.

**REFERENCES:**

1. Discrete Event System Simulation *I* Banks J. & Carson J.S., PH *I* Englewood Cliffs N/ 1984.
2. A Course in Simulation / Ross, S.M., McMillan, NY, 1990.
3. Simulation Modelling and S1MNET/ Taha HA. / PH, Englewood Cliffs, NJ, 1987

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## OPTIMIZATION AND RELIABILITY

**UNIT - I**

**Classical optimization techniques:** Single variable optimization withand without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – method of Lagrange multipliers, Kuhn-Tucker conditions.

**UNIT - II**

**Numerical methods for optimization:** Nelder Mead's Simplex searchmethod, 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 betweenconventional 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 Arora, Mc Graw Hill (International) Publishers
2. Optimization for Engineering Design – Kalyanmoy Deb, PHI Publishers
3. Engineering Optimization – S.S.Rao, New Age Publishers

**REFERENCES:**

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

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## 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.

**UNIT - II**

**Raster scan graphics:** Line drawing algorithms – DDA &Bresenhamalgorithms, circle generation, general function rasterization, displaying lines, characters and polygons.

**Filling algorithms:** polygon filling, edge fill algorithm, seed fillalgorithm, fundamentals of antialiasing and half toning.

**UNIT - III**

**Line CLIPPING:** Simple visibility algorithm, Cohen-Sutherlandsubdivision line clipping algorithm, mid point sub division algorithm. **Polygon clipping:** polygon clipping, reentrant polygon clipping – Sutherland – Hodgeman algorithm, character clipping, 3D- clipping.

**UNIT - IV**

**Transformations:** Cartesian and homogeneous coordinate systemstwo dimensional and three dimensional transformations – scaling, rotation, Shearing, Zooming, viewing transformation, reflection, rotation about an axis, concatenation.

**UNIT - V**

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

**Shading algorithms:** Constant intensity algorithm, Phong's shadingalgorithm, gourand shading algorithm, Comparison of shading algorithms.

**TEXT BOOKS:**


1. Procedural elements for computer graphics-D.F.Rogers, Tata McGraw-Hill.
2. Computer Graphics-Donald Hearn & M.P. Bakers.
3. Computer graphics-Harrington.
4. http://nptel.ac.in/courses/106102065/
5. http://nptel.ac.in/courses/Webcourse-contents/IIT-Delhi/Computer%20Graphics/csmain.htm
6. http://nptel.ac.in/courses/106106090/

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## ADVANCED FINITE ELEMENT METHODS

**UNIT-I:**

Introduction to FEM, basic concepts, historical back ground, applications of FEM, general description,comparison of FEM with other methods, variational approach, Glerkin's Methods. Co-ordinates, basicelement shapes, interpolation function, Virtual energy principle, Rayleigh – Ritz method, properties ofstiffness matrix, treatment of boundary conditions, shape functionsand characteristics, Basic equations of elasticity, strain- displacement relations.

**UNIT-II:**

**1-D Structural Problems**: Axial bar element – stiffness matrix, load vector, temperature effects,Quadratic shape functions and problems.

**Analysis of Trusses:** Plane Trusses and Space Truss elements and problems

**Analysis of Beams**:Hermite shape functions – stiffness matrix – Load vector – Problems.

**UNIT-III:**

**2-D problems:** CST, LST, force terms, Stiffness matrix and load vectors, boundary conditions,Isoparametric elements – quadrilateral element, shape functions – Numerical Integration.

Finiteelement modeling of Axi-symmetric solids subjected to Axi-symmetric loading with triangularelements.

**UNIT-IV:**

**3-D Problems**: Tetrahedran element – Jacobian matrix – Stiffness matrix

**Scalar Field Problems**: 1-D Heat conduction-Slabs – fins - 2-D heat conduction problems – Introduction to Torsional problems.

**UNIT-V:**

Dynamic considerations, Dynamic equations – consistent mass matrix – Eigen Values, Eigen vector,natural frequencies – mode shapes – modal analysis.

**TEXT BOOKS:**

1. Finite Element Methods: Basic Concepts and applications, Alavala, PHI.

2. Finite Element Method – Zincowitz / Mc Graw Hill

**REFERENCES:**

1. The Finite Element Methods in Engineering / SS Rao / Pergamon.

2. Introduction to Finite Elements in Engineering, Chandrupatla, Ashok and Belegundu, Prentice – Hall

3. Introduction to Fininte element analysis- S.Md.Jalaludeen,Anuradha Publications, print-2012

4. A First Course in the Finite Element Method/Daryl L Logan/Cengage Learning/5th Edition

5. Finite Element Method – Krishna Murthy / TMH 6. Finite Element Analysis – Bathe / PHI

6. http://nptel.ac.in/courses/112106130/

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## QUALITY ENGINEERING IN MANUFACTURING
## (ELECTIVE III)

**UNIT I:**

**QUALITY VALUE AND ENGINEERING:** An overall quality system,quality engineering in production design, quality engineering in design of production processes. Loss Function and Quality Level: Derivation and use of 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. Parameter and Tolerance Design: Introduction to parameter design, signal to noise ratios, Parameter design strategy, some of the case studies on parameter and tolerance designs.

**UNIT – III**

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

**UNIT - IV**

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

**UNIT - V**

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

**TEXT BOOK:**

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

**REFERENCES:**

1. Quality Engineering in Production systems by G. Taguchi, A. Elsayed et al, McGraw Hill Intl. Pub 1989.
2. Taguchi Methods explained: Practical steps to Robust Design /Papan P. Bagchi*I* Prentice Hall Pvt. Ltd., New Delhi.
3. http://nptel.ac.in/courses/112107142/15
4. http://nptel.ac.in/courses/112107142/12

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## FRACTURE MECHANICS
## (ELECTIVE III)

**UNIT-I**

**Introduction:** Prediction of mechanical failure. Macroscopic failuremodes; brittle and ductile behaviour. Fracture in brittle and ductile materials – characteristics of fracture surfaces; inter-granular and intra-granular failure, cleavage and micro-ductility, growth of fatigue cracks, The ductile/brittle fracture transition temperature for notched and unnotched components. Fracture at elevated temperature.

**UNIT-II**

**Griffiths analysis: C**oncept of energy release rate, G, and fractureenergy, R. Modification for ductile materials, loading conditions. Concept of R curves.

**Linear Elastic Fracture Mechanics, (LEFM).** Three loading modesand the state of stress ahead of the crack tip, stress concentration factor, stress intensity factor and the material parameter the critical stress intensity factor, crack tip plasticity, effect of thickness on fracture toughness.

**UNIT-III**

**Elastic-Plastic Fracture Mechanics; (EPFM).** The definition ofalternative failure prediction parameters, Crack Tip Opening Displacement, and the J integral. Measurement of parameters and examples of use.

**UNIT-IV**

**Fatigue:** Definition of terms used to describe fatigue cycles, High CycleFatigue, Low Cycle Fatigue, mean stress R ratio, strain and load control. S-N curves. Goodmans rule and Miners rule. Micromechanisms of fatigue damage, fatigue limits and initiation and propagation control, leading to a consideration of factors enhancing fatigue resistance. Total life and damage tolerant approaches to life prediction.

**UNIT-V**

**Creep deformation:** The evolution of creep damage, primary, secondaryand tertiary creep. Micro-mechanisms of creep in materials and the role of diffusion. Ashby creep deformation maps. Stress dependence of creep – power law dependence. Comparison of creep performance under different conditions – extrapolation and the use of Larson-Miller parameters. Creep-fatigue interactions. Examples.

**TEXT BOOKS:**

1. T.L. Anderson, Fracture Mechanics Fundamentals and Applications, 2nd Ed. CRC press, (1995)
2. J.F. Knott, Fundamentals of Fracture Mechanics, Butterworths (1973)
3. G. E. Dieter, Mechanical Metallurgy, McGraw Hill, (1988)
4. S. Suresh, Fatigue of Materials, Cambridge University Press, (1998)

**REFERENCES:**

1. B. Lawn, Fracture of Brittle Solids, Cambridge Solid State Science Series 2nd ed1993.
2. J.F. Knott, P Withey, Worked examples in Fracture Mechanics, Institute of Materials.
3. H.L.Ewald and R.J.H. Wanhill Fracture Mechanics, Edward Arnold, (1984).
4. L.B. Freund and S. Suresh, Thin Film Materials Cambridge University Press,(2003).
5. D.C. Stouffer and L.T. Dame, Inelastic Deformation of Metals, Wiley (1996)
6. http://nptel.ac.in/courses/112106065/5
7. http://nptel.ac.in/courses/112106065/

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**CONCURRENT ENGINEERING**
**(ELECTIVE III)**

**UNIT- I**

**INTRODUCTION**

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

**USE OF INFORMATION TECHNOLOGY**

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

**UNIT- II**

**DESIGN STAGE**

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

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

**UNIT- III**

**MANUFACTURING CONCEPTS AND ANALYSIS**

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

**UNIT- IV**

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

**PROJECT MANAGEMENT**

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

**UNIT- V**

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

**TEXT BOOKS:**

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

**REFERENCES:**

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

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**MECHANICS AND MANUFACTURING METHODS OF COMPOSITES**
**(ELECTIVE IV)**

**UNIT – I**

**Basic concepts and characteristics:** Geometric and Physical definitions,natural and man-made composites, Aerospace and structural applications, types and classification of composites, Fibres-Glass, Silica, Kevlar, carbon, boron, silicon carbide, and born carbide fibres. Particulate composites, Polymer composites, Thermoplastics, Thermosets, Metal matrix and ceramic composites.

**UNIT – II**

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

**Coordinate transformations:** Hooke's law for different types ofmaterials, 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 – III**

**Elastic behavior of unidirectional composites**: Elastic constants oflamina, relation ship between engineering constants and reduced stiffness and compliances, analysis of laminated composites, constitutive relations.

**Strength of unidirectional lamina:** Micro mechanics of failure, Failuremechanisms, Strength of an orthotropic lamina, Strength of a lamina under tension and shear maximum stress and strain criteria, application to design. The failure envelope, first ply failure, free-edge effects. Micro mechanical predictions of elastic constants.

**UNIT – IV**

Analysis of laminated composite plates Introduction, thin plate theory, specially orthotropic plate, cross and angle ply laminated plates, problems using thin plate theory.

**UNIT – V**

**Manufacturing methods:** Autoclave, tape production, mouldingmethods, filament winding, man layup, pultrusion, RTM.

**TEXT BOOKS:**

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

**REFERENCES:**

1. B. D. Agarwal and L. J. Broutman, Analysis and performance of fibre Composites, Wiley-Interscience, New York, 1980.
2. L. R. Calcote, Analysis of Laminated Composite Structures, Van NostrandRainfold, New York, 1969.
3. http://nptel.ac.in/courses/112104168/

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## MATERIALS TECHNOLOGY
## (ELECTIVE IV)

**UNIT- I**

Elasticity in metals and polymers, mechanism of plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals, strengthening mechanism, work hardening, solid solution, grain boundary strengthening. Poly phase mixture, precipitation, particle, fiber and dispersion strengthening, effect of temperature, strain and strain rate on plastic behavior, super plasticity, deformation of non crystalline material

**UNIT- II**

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

**UNIT- III**

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

**UNIT- IV**

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

**UNIT- V**

**NONMETALLIC MATERIALS**: Polymeric materials and their molecularstructures, Production Techniques for Fibers, Foams, Adhesives and Coatings, structure, Properties and Aplications of Engineering Polymers, Advanced Structural Ceramics WC, TiC, TaC, A12 O3, SiC, Si3 N4, CBN and Diamond – properties, Processing and applications.

**TEXT BOOKS:**

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

**REFERENCES:**

1 Selection and use of Engineering Materials 3e/Charles J.A/Butterworth Heiremann.
2 Engineering Materials Technology/James A Jacob Thomas F Kilduff/ Pearson
3 Material Science and Engineering/William D Callister/John Wiley and Sons
4. http://nptel.ac.in/courses/113105028/
5. http://nptel.ac.in/courses/113106032/

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**INTELLIGENT MANUFACTURING SYSTEMS**
**(ELECTIVE IV)**

**UNIT- I**

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

**UNIT-II**

**COMPONENTS OF KNOWLEDGE BASED SYSTEMS** - BasicComponents of Knowledge Based Systems, Knowledge Representation, Comparison of Knowledge Representation Schemes, Interference Engine, Knowledge Acquisition.

**UNIT- III**

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

**UNIT- IV**

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

**UNIT- V**

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

**TEXT BOOKS:**

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

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## MODELING AND ANALYSIS OF MANUFACTURING PROCESSES LAB

Students shall carry out the modeling and FE analysis of at least three processes of each category given below.

1. Casting processes - Simulation of Solidification, temperatures, Residual stresses, metallurgical phases etc.
2. Forging processes - Simulation of cold working and hot working processes for extrusion, drawing, rolling, etc.
3. Forming Processes – Simulation of blanking, bending, deep drawing, etc.
4. Welding Processes – Simulation of arc, spot, laser welding, etc