COURSE STRUCTURE AND SYLLABUS

for

M.Tech

Specialization: CAD/CAM

MECHANICAL ENGINEERING

(*Applicable for batches admitted from 2019-20*)

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

R19 M.TECH CAD/CAM COURSE STRUCTURE

I Semester

S.No.	Subject Code	Title of the Subject	L	P	C
1	19061T01	INDUSTRIAL ROBOTICS	3	-	3
2	19061T02	COMPUTER AIDED MANUFACTURING	3	-	3
3	19061T03	SPECIAL MANUFACTURING PROCESSES	3		3
4	**ELECTIVE I**		3	-	3
	19061D01	COMPUTATIONAL METHODS IN ENGINEERING			
	19061D02	MECHANICAL VIBRATIONS			
	19061D03	CONCURRENT ENGINEERING			
5	**ELECTIVE II**		3	-	3
	19061D04	DESIGN FOR MANUFACTURING & ASSEMBLY			
	19061D05	MECHATRONICS			
	19061D06	COMPUTER AIDED PROCESS PLANNING			
6	19061L01	ADVANCED CAD LAB	-	4	2
		Total Credits			**17**

II Semester

S.No.	Subject Code	Title of the Subject	L	P	C
1	19062T04	OPTIMIZATION AND RELIABILITY	3	-	3
2	19062T05	COMPUTER GRAPHICS	3	-	3
3	19062T06	ADVANCED FINITE ELEMENT METHODS	3	-	3
4	**ELECTIVE III**		3	-	3
	19062D07	QUALITY ENGINEERING IN MANUFACTURING			
	19062D08	FRACTURE MECHANICS			
	19062D09	FLEXIBLE MANUFACTURING SYSTEMS			
5	**ELECTIVE IV**		3	-	3
	19062D10	MECHANICS AND MANUFACTURING METHODS OF			
	19062D11	RAPID PROTOTYPING			
	19062D12	INTELLIGENT MANUFACTURING SYSTEMS			
6	19062L02	ADVANCED CAM LAB	-	4	2
		Total Credits			**17**

III Semester

S.No.	Subject Code	SUBJECT(S)	L	P	C
1	19063T07	GEOMETRIC MODELING	3	-	3
2	19063T08	PRODUCT DESIGN AND DEVELOPMENT	3	-	3
3	19063C01	COMPREHENSIVE VIVA	-	-	3
4	19063S01	SEMINAR-I	-	-	2
5	19063P01	PROJECT WORK PART – I	-	18	9
		Total Credits			**20**

IV Semester

S.No.	Subject Code	SUBJECT(S)	L	P	C
1	19064S02	SEMINAR-II	-	-	2
2	19064P02	PROJECT WORK PART – II	-	24	12
		Total Credits			**14**

Total Course Credits = 17+17+20+14 = 68

SYLLABUS

M.Tech I Year I Semester **R19** **Specialization: CAD/CAM**

INDUSTRIAL ROBOTICS

Course Category	Professional Core		
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Exposure to Dynamics, Computer Programming and Problem Solving.	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To develop the student knowledge in various robot components and their workspace.
2	To develop student skills in performing spatial transformations associated with rigid body motions.
3	To develop student skills in developing kinematics analysis of robot systems.
4	To provide the student with some knowledge and skill on robot programming and languages for different robotic tasks.
5	To provide analysis skills to student towards the application of robot system with association of robot control.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Apply the manipulator design including actuator, drive and sensor issues.	k3
CO2	Analyze the forward kinematics, inverse kinematics and Jacobian for serial and parallel robots.	k4

CO3	Identify different types of end effectors and sensors required for specific applications.	k3
CO4	Develop programming principles and languages for a robot control system.	k3
CO5	Assess various applications of industrial robot systems with cell controller.	k5

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes

(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	3	-	3	1
CO2	2	3	2	3
CO3	-	3	2	2
CO4	3	2	-	3
CO5	3	1	2	1

COURSE CONTENT	
UNIT I	**INTRODUCTION**: Automation and Robotics, Robot anatomy, robot configuration, motions joint notation scheme, work volume, robot drive systems, control systems and dynamic performance, precision of movement. **CONTROL SYSTEM AND COMPONENTS:** basic concepts and motion controllers, control system analysis, robot actuation and feedback components, Positions sensors, velocity sensors, actuators, power transmission systems, robot joint control design.
UNIT II	**MOTION ANALYSIS AND CONTROL:** Manipulator kinematics, position representation, forward and inverse transformations, homogeneous transformations, manipulator path control, robot arm dynamics, configuration of a robot controller.
UNIT III	**END EFFECTORS:** Grippers-types, operation, mechanism, force analysis, tools as end effectors consideration in

	gripper selection and design. SENSORS: Desirable features, tactile, proximity and range sensors, uses sensors in robotics. **MACHINE VISION:** Functions, Sensing and Digitizing-imaging devices, Lighting techniques, Analog to digital single conversion, image storage: Image processing and Analysis-image data reduction, Segmentation, feature extraction, Object recognition. Training the vision system, Robotic application.
UNIT IV	**ROBOT PROGRAMMING:** Lead through programming, Robot program as a path in space, Motion interpolation, WAIT, SIGNAL AND DELAY commands, Branching, capabilities and Limitations of lead through methods. **ROBOT LANGUAGES**: Textual robot Languages, Generations of robot programming languages, Robot language structures, Elements and function.
UNIT V	**ROBOT CELL** DESGIN AND CONTROL: Robot cell layouts-Robot centered cell, In-line robot cell, Considerations in work design, Work and control, Inter locks, Error detection, Work cell controller. **ROBOT APPLICATION**: Material transfer, Machine loading/unloading, Processing operation, Assembly and Inspection, Future Application.

TEXT BOOKS	
1	Industrial Robotics / Groover M P /Pearson Edu.
2	Introduction to Robotic Mechanics and Control by JJ Craig, Pearson, 3rd edition.
REFERENCE BOOKS	
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
WEB RESOURCES	
1	https://nptel.ac.in/courses/112101098/
2	http://www.robotplatform.com/knowledge/sensors/types_of_robot_sensors.html
3	https://nptel.ac.in/downloads/112103174/

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M.Tech I Year I Semester **R19** **Specialization: CAD/CAM**

COMPUTER AIDED MANUFACTURING

Course Category	Professional Core		
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment**	40
		Semester End Examination	60
		Total Marks	100

COURSE OBJECTIVES	
1	Understand the APT and NC programming on CAD/CAM systems.
2	Exposure to the CNC tooling systems and adaptive control of machining processes.
3	Understand the general structure and functions of a post processor in CNC.
4	Understand the hardware components, micro controller, PLC's in CNC machines.
5	Study the computer aided process planning, coordinate measuring systems; computer aided testing and inspection methods.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Explain the APT and NC programming on CAD/CAM systems.	k2
CO2	Organize the tooling for CNC machines for CNC machines and adaptive	k3

	control of machining processes like turning, grinding	
CO3	Explain the general structure and functions of DAPP based post processor.	k4
CO4	Importance of the hardware components, micro controller, PLC's in CNC machines.	k5
CO5	Develop the AI & Expert systems to the computer aided process planning, computer aided testing and inspection methods.	k6

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes

(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	3	3	3
CO2	2	3	3	3
CO3	2	3	3	3
CO4	2	3	3	3
CO5	2	3	3	3

COURSE CONTENT	
UNIT I	**COMPUTER AIDED PROGRAMMING:** General information, APT programming, 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 arid disadvantages of DNC, adaptive control with optimization, Adaptive control with constrains, 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, the creation of a DAPP — Based Post Processor.
UNIT IV	**MICRO CONTROLLERS:** Introduction, Hardware components, I/O pins, ports, external memory:, counters, timers and serial data I/O interrupts. Selection of Micro Controllers Embedded Controllers, Applications and Programming of Micro Controllers. Programmable Logic Controllers (PLC's): Introduction, Hardware components of PLC, System, basic structure, principle of operations, Programming mnemonics timers, Internal relays and counters, Applications of PLC's in CNC Machines.
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- Yoram Koren, Mc Graw Hill. 1983.
2	CAD/CAM Principles and Applications, P.N.Rao, TMH
REFERENCE BOOKS	
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, Farid Amirouche, Pearson
5	Computer Numerical Control Concepts and programming, Warren S Seames, Thomson.

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M.Tech I Year I Semester **R19** **Specialization: CAD/CAM**

SPECIAL MANUFACTURING PROCESSES

Course Category	Professional Core		
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment**	40
		Semester End Examination	60
		Total Marks	100

COURSE OBJECTIVES	
1	To study different coatings and associated surface treatment processes.
2	To study various stages involved in the processing of Ceramics.
3	To learn about different methods for preparation of Micro Electronic Components.
4	To learn various sophisticated machining processes for processing of high strength materials / general materials with greater accuracy.
5	To study about various methods and the principles involved in Rapid Prototyping.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Evaluate the required treatment necessary for a particular application	k5

CO2	Understand various stages involved in the processing of Ceramics.	k2
CO3	Apply the knowledge of various techniques for the fabrication of Micro Electronic Components.	k3
CO4	Analyze the forces involved in various machining processes and adopt the suitable process for machining of the components of various strength materials.	k4
CO5	Apply the knowledge of various techniques and methods for the fabrication.	k3

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes

(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	-	2	-	3
CO2	2	2	-	2
CO3	2	2	2	2
CO4	3	2	-	3
CO5	2	2	-	3

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

UNIT II	**PROCESSING OF CERAMICS:** Applications, characteristics, classification .Processing of particulate ceramics, Powder preparations, consolidation, Drying, sintering, Hot compaction, Area of application, finishing of ceramics. Processing of Composites: Composite Layers, Particulate and fiber reinforced composites, Elastomers, Reinforced plastics, MMC, CMC, Polymer matrix composites.
UNIT III	**FABRICATION OF MICROELECTRONIC DEVICES**: Crystal growth and wafer preparation, Film Deposition oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, computer aided design in micro electronics, surface mount technology, Integrated circuit economics.
UNIT IV	**ADVANCED MACHINING PROCESSES:** EDM, WireEDM, ECM, LBM, EBM, AJM, WJM – Principle, working, limitations and applications.
UNIT V	**RAPID PROTOTYPING:** Working Principles, Methods, Stereo Lithography, Laser Sintering, Fused Deposition Method, Applications and Limitations, Rapid tooling, Techniques of rapid manufacturing

TEXT BOOKS	
1	Manufacturing Engineering and Technology, Serope Kalpakijian , Steven R Schmid,7th Edition,Pearson .
2	Process and Materials of Manufacture ,Roy A Lindburg,4th Edition,PHI.
REFERENCE BOOKS	
1	Microelectronic packaging handbook ,Rao. R. Thummala and Eugene, J. Rymaszewski ,Van Nostrand Renihold,1989,Rheinhold Publishers.
2	MEMS & Micro Systems:Design and manufacture ,Tai -Run Hsu,Mc Graw-Hill,2002.
3	Advanced Machining Processes ,V.K.Jain ,1st Edition,Allied Publications.
4	Introduction to Manufacturing Processes ,John A Schey , 2nd Edition,Mc Graw-Hill
WEB RESOURCES	
1	http://nptel.ac.in/courses/112107145/7

SYLLABUS

M.Tech I Year I Semester **R19** **Specialization: CAD/CAM**

COMPUTATIONAL METHODS IN ENGINEERING

(ELECTIVE-I)

Course Category	Basic Sciences		
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment**	40
		Semester End Examination	60
		Total Marks	100

COURSE OBJECTIVES	
1	To understand concepts of numerical methods commonly used for analysis and design in engineering applications.
2	To study the boundary and characteristic value problems for engineering applications.
3	To learn transformation techniques for engineering applications.
4	To understand numerical Differentiation, Integration and numerical solutions of ordinary and partial differential equations.
5	To understand the partial differential equations.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Explain the numerical techniques to find the roots of nonlinear equations and solution of system of linear equations.	k2

CO2	Solve the boundary and characteristic value problems for engineering applications.	k3
CO3	Analyze the transformation techniques for engineering applications.	k4
CO4	Apply the principles of numerical Differentiation, Integration and numerical solutions of ordinary and partial differential equations to engineering applications.	k3
CO5	Analyze the principles of partial differential equations to engineering applications.	k4

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes

(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	3	2	2	2
CO2	3	3	2	3
CO3	3	3	2	3
CO4	3	3	2	3
CO5	3	3	3	3

COURSE CONTENT	
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	**Boundary value problems and characteristic value problems:** Shooting method – Solution through a set of equations – Derivative boundary conditions – Rayleigh – Ritz method – Characteristic value problems
UNIT III	**Transformation Techniques:** Continuous fourier series, frequency and 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's equations – Representations as a difference equation – Iterative methods for Laplace's equations – poisson equation – Examples – Derivative boundary conditions – Irregular and non – rectangular grids – Matrix patterns, sparseness – ADI method – Finite element method.
UNIT V	**Partial differential equations:** Explicit method – Crank-Nickelson method – 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
REFERENCE BOOKS	
1	Ward Cheney and David Kincaid "Numerical mathematics and computing"Brooks/Cole publishing company1999, Fourth edition.
2	Riley K.F,. M.P.Hobson and Bence S.J,"Mathematical methods for physics and engineering", Cambridge University press,1999.
3	Kreysis, Advanced Mathematics.
WEB RESOURCES	
1	http://nptel.ac.in/courses/103106074/

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M.Tech I Year I Semester **R19** **Specialization: CAD/CAM**

MECHANICAL VIBRATIONS
(ELECTIVE-I)

Course Category	Professional Core		
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment**	40
		Semester End Examination	60
		Total Marks	100

COURSE OBJECTIVES	
1	To understand the behaviour of single degree freedom systems and the role of mass, stiffness and damping.
2	To understand the equations of motion at various nan periodic excitations.
3	To study the simple mechanical systems that can be approximated by multi degree of freedom systems.
4	To study the numerical methods for the solution of analytical problems in vibrations.
5	Select appropriate techniques for the solution of analytical problems in vibrations.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Explain the concepts of vibration and single degree of freedom systems.	k2

CO2	Solve the obtained equations of motion to understand the various excitations such as harmonic excitation and impulse excitation.	k3
CO3	Examine vibration design of simple mechanical systems that can be approximated by multi degree of freedom systems	k4
CO4	Select appropriate numerical method for the solution of analytical problems in vibrations.	k5
CO5	Adapt the concepts of vibrations to solve engineering problems	k6

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes

(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	3	3	2	3
CO2	3	3	2	3
CO3	3	3	2	3
CO4	3	3	2	3
CO5	3	3	3	3

COURSE CONTENT	
UNIT I	**Single degree of Freedom systems:** Undamped and damped free vibrations: forced vibrations ; coulomb damping; Response to harmonic excitation; rotating unbalance and support excitation, Vibration isolation and transmissibility, Vibrometers, velocity meters & accelerometers.

UNIT II	**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 III	**Multi degree freedom systems:** Principal modes – undamped and damped 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 IV	**Numerical Methods:** Rayliegh's, Stodola's, Matrix iteration, Rayleigh-Ritz Method and Holzer's methods.
UNIT V	**Application of concepts:** Free vibration of strings – longitudinal oscillations 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.
REFERENCE BOOKS	
1	Vibrations by W.T. Thomson
2	Mechanical Vibrations – Schaum series.
3	Vibration problems in Engineering by S.P. Timoshenko
4	Mechanical Viabrations – V.Ram Murthy.
WEB RESOURCES	
1	http://www.nptelvideos.in/2012/12/mechanical-vibrations.html

SYLLABUS

M.Tech I Year I Semester **R19** **Specialization: CAD/CAM**

CONCURRENT ENGINEERING

(ELECTIVE - I)

Course Category	Professional Elective		
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment**	40
		Semester End Examination	60
		Total Marks	100

COURSE OBJECTIVES	
1	Understand the basic tools and methodologies available in CE.
2	Learn conventional and intelligent manufacturing system design.
3	Learn CE approach to economical project management.
4	Learn concurrent engineering system for product and process in automated manufacturing enterprises.
5	Plan for project management on new product development.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Understand the concurrent engineering design methodologies.	k2
CO2	Identify and apply different computational techniques to the concurrent Engineering.	k3
CO3	Apply the concepts of product design by adopting different methods.	k3
CO4	Analyze the concepts of manufacturing which enhance the design process of manufacturing systems.	k4
CO5	Develop real-life new product/process scenarios.	k6

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes

(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	1	2	-	-
CO2	1	2	-	2
CO3	2	2	2	3
CO4	2	2	2	3
CO5	2	2	2	3

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

SYLLABUS

M.Tech I Year I Semester **R19** **Specialization: CAD/CAM**

DESIGN FOR MANUFACTURING AND ASSEMBLY

(ELECTIVE- II)

Course Category	Professional Elective		
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment**	40
		Semester End Examination	60
		Total Marks	100

COURSE OBJECTIVES	
1	Understand various steps in DFMA and their applications.
2	Study the rules in design processes and general recommendations for design of machine parts.
3	Learn different Metal casting and forming processes and general considerations for design of machine parts and assembly.
4	Types of Metal joining processes and general guidelines for design of machining processes.
5	Study the fundamentals of design for assembly automation.

COURSE OUTCOMES	
Upon successful completion of the course, the student will be able to:	**Cognitive**

		Level*
CO1	Illustrate design processes and effects on manufacturing process	k2
CO2	Aware of design various components for machining.	k2
CO3	Learn about the metal casting; developments of sheet metal work and extrusion.	k3
CO4	Summarize welding and forging processes considering real time factors.	k5
CO5	Grasp the knowledge of Fundamentals of automated assembly systems and workstations.	k2

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes

(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	2	1	1
CO2	2	2	2	1
CO3	2	3	3	1
CO4	2	3	2	1
CO5	2	3	3	3

COURSE CONTENT	
UNIT I	Introduction to DFM, DFMA: How Does DFMA Work? Reasons for Not Implementing DFMA, What Are the Advantages of Applying DFMA During Product Design?, Typical DFMA Case Studies, Overall Impact of DFMA on Industry.

	Design for Manual Assembly: General Design Guidelines for Manual Assembly, Development of the Systematic DFA Methodology, Assembly Efficiency, Effect of Part Symmetry, Thickness, Weight on Handling Time, Effects of Combinations of Factors, Application of the DFA Methodology.
UNIT II	Machining processes: Overview of various machining processes-general design rules for machining-dimensional tolerance and surface roughness-Design for machining – ease – redesigning of components for machining ease with suitable examples. General design recommendations for machined parts.
UNIT III	Metal casting: Appraisal of various casting processes, selection of casting process,-general design considerations for casting-casting tolerance-use of solidification, simulation in casting design-product design rules for sand casting. **Extrusion & Sheet metal work:** Design guide lines extruded sections-design principles for punching, blanking, bending, deep drawing-Keeler Goodman forging line diagram – component design for blanking.
UNIT IV	Metal joining: Appraisal of various welding processes, factors in design of weldments – general design guidelines-pre and post treatment of welds-effects of thermal stresses in weld joints-design of brazed joints. Forging: Design factors for forging – closed die forging design – parting lines of dies – drop forging die design – general design recommendations.
UNIT V	Design for Assembly Automation: Fundamentals of automated assembly systems, System configurations, parts delivery system at workstations, various escapement and placement devices used in automated assembly systems, Quantitative analysis of Assembly systems, Multi station assembly systems, single station assembly lines.

TEXT BOOKS	
1	Design for manufacture, John cobert, Adisson Wesley. 1995
2	Design for Manufacture by Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knigh
REFERENCE BOOKS	
1	Design for manufacture, James Bralla

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M.Tech I Year I Semester **R19** **Specialization: CAD/CAM**

MECHATRONICS

(ELECTIVE- II)

Course Category	Professional Elective		
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Exposure to	**Internal Assessment**	40
		Semester End Examination	60
		Total Marks	100

COURSE OBJECTIVES	
1	Frame of reference on mechatronic systems and their response.
2	Functioning of solid state electronic devices.
3	Overview of various actuating systems
4	Programming of microprocessors and microcontrollers in various fields.
5	Overview of interfacing the system, data acquisition and signal conditioning in manipulation of analog signals.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Able to grasp the knowledge to Demonstrate the mechatronic systems in	k1

	various industrial fields	
CO2	Aware about the functioning of solid state electronic devices.	k2
CO3	Able to learn about the hydraulic and pneumatic actuating systems.	k3
CO4	Aware about the measuring of physical quantities using digital electronics and systems.	k5
CO5	Able to Create system interfacing and data acquisition.	k6

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes

(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	3	-	3	1
CO2	2	3	2	3
CO3	-	3	2	2
CO4	3	2	-	3
CO5	3	1	2	1

COURSE CONTENT	
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	1. MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran & GK Vijaya Raghavan/WILEY India Edition/2008
2	2. Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering by W Bolton, Pearson Education Press, 3rd edition, 2005.
REFERENCE BOOKS	
1	Mechatronics Source Book by Newton C Braga, Thomson Publications, Chennai
2	Mechatronics – N. Shanmugam / Anuradha Agencies Publishers
3	Mechatronics System Design / Devdas shetty/Richard/Thomson
4	Mechatronics/M.D.Singh/J.G.Joshi/PHI
5	Mechatronics – Electronic Control Systems in Mechanical and Electrical Engg. 4th Edition, Pearson, 2012 W. Bolton

SYLLABUS

M.Tech I Year I Semester **R19** **Specialization: CAD/CAM**

COMPUTER AIDED PROCESS PLANNING

(ELECTIVE- II)

Course Category	Professional Elective		
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Exposure to	**Internal Assessment**	40
		Semester End Examination	60
		Total Marks	100

COURSE OBJECTIVES	
1	To learn the basics and applications of automation in process planning.
2	To understand various CAPP systems, significance of Group technology and its applications.
3	To understand the importance and advantages of selecting proper manufacturing sequence and machining parameters.
4	To determine various tolerances and their integration.
5	To understand the generation implementation of tool path and various programming languages for CAPP.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Describe the structure and advantages of Automated process planning system.	k2

CO2	Apply the principles of generative, retrieval CAPP systems and Group technology which helps in reducing cost and improving quality.	k3
CO3	Select the appropriate manufacturing sequence , machining parameters and understand how they affect on setup cost and surface quality.	k4
CO4	Calculate the tolerances and understand its importance in manufacturing.	k4
CO5	Develop the tool path and apply the various languages for CAPP.	k6

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes

(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	2	1	1
CO2	2	2	3	2
CO3	3	3	1	3
CO4	2	2	1	2
CO5	2	2	-	2

COURSE CONTENT	
UNIT I	**Introduction to CAPP:** Information requirement for process planning system, Role of process planning, advantages of conventional process planning over CAPP, Structure of Automated process planning system, feature recognition, methods.
UNIT II	**Generative CAPP system:** Importance, principle of Generative CAPP system, automation of logical decisions, Knowledge based systems, Inference Engine, implementation, benefits.

	Retrieval CAPP system: Significance, group technology, structure, relative advantages, implementation, and applications.
UNIT III	**Selection of manufacturing sequence:** Significance, alternative manufacturing processes, reduction of total set-up cost for a particular sequence, quantitative methods for optimal selection, examples. **Determination of machining parameters:** reasons for optimal selection of machining parameters, effect of parameters on production rate, cost and surface quality, different approaches, advantages of mathematical approach over conventional approach, solving optimization models of machining processes.
UNIT IV	**Determination of manufacturing tolerances:** design tolerances, manufacturing tolerances, methods of tolerance allocation, sequential approach**,** integration of design and manufacturing tolerances, advantages of integrated approach over sequential approach
UNIT V	**Generation of tool path:** Simulation of machining processes, NC tool path generation, graphical implementation, determination of optimal index positions for executing fixed sequence, quantitative methods. **Implementation techniques for CAPP:** MIPLAN system, Computer programming languages for CAPP, criteria for selecting a CAPP system and benefits of CAPP. Computer integrated planning systems, and Capacity planning system.

TEXT BOOKS	
1	Computer Aided Process Planning – Joseph Tulkoff, SME Publications
2	Computer Aided Process Planning – Hsu-Pin Wang, Jian-Kang Li, Elsevier
REFERENCE BOOKS	
1	Automation , Production systems and Computer Integrated Manufacturing System – Mikell P. Groover
2	Computer Aided Design and Manufacturing – Sadhu Singh.
3	Computer Aided Engineering – David Bedworth

SYLLABUS

M.Tech I Year I Semester **R19** **Specialization: CAD/CAM**

ADVANCED CAD LAB

Course Category	Lab Course		
Course Type	Laboratory	**L-T-P-C**	0-0-4-2
Prerequisites		**Internal Assessment**	40
		Semester End Examination	60
		Total Marks	100

COURSE OBJECTIVES	
1	To carry out the modeling and FE analysis of trusses, beams, plates and cylinders

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Describe the modeling and FE analysis of trusses, beams, plates and cylinders	k2

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes

(1 – Low, 2 - Medium, 3 – High)

	PO1	PO2	PO3	PSO1
CO 1	3	3	3	3

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

SYLLABUS

M.Tech I Year II Semester **R19** **Specialization: CAD/CAM**

OPTIMIZATION AND RELIABILITY

Course Category	Professional Core		
Course Type	Theory	**L-T-P-C**	4-0-0-4
Prerequisites		**Internal Assessment**	40
		Semester End Examination	60
		Total Marks	100

COURSE OBJECTIVES	
1	To study classical optimization techniques
2	To get knowledge of numerical methods for optimization
3	To learn genetic algorithm and genetic programming
4	To apply optimization in design and manufacturing systems
5	To understand reliability concepts

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Apply Principles of optimization and conventional optimization techniques to various problems	k3
CO2	Apply numerical methods for optimization to optimization related problems	k3

CO3	Apply genetic algorithm and genetic programming	k3
CO4	Apply and Solve optimization in design and manufacturing systems	k3
CO5	To understand reliability concepts	k2

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes

(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	3	3	1
CO2	3	2	3	2
CO3	2	3	3	2
CO4	3	3	2	2
CO5	2	3	1	2

COURSE CONTENT	
UNIT I	**CLASSICAL OPTIMIZATION TECHNIQUES:** Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – method of Lagrange multipliers, Kuhn-Tucker conditions, merits and demerits of classical optimization techniques.
UNIT II	**NUMERICAL METHODS FOR OPTIMIZATION:** Nelder Mead's Simplex search method, Gradient of a function, Steepest descent method, Newton's method, Pattern search methods, conjugate method, types of penalty methods for handling constraints, advantages of numerical methods.
UNIT III	**GENETIC ALGORITHM (GA) :** Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained

	optimization, draw backs of GA, **GENETIC PROGRAMMING (GP):** Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP. **MULTI-OBJECTIVE GA:** Pareto's analysis, Non-dominated front, multi – objective GA, Non-dominated sorted GA, convergence criterion, applications of multi-objective problems .
UNIT IV	**APPLICATIONS OF OPTIMIZATION IN DESIGN AND MANUFACTURING SYSTEMS:** Some typical applications like optimization of path synthesis of a four-bar mechanism, minimization of weight of a cantilever beam, optimization of springs and gears, general optimization model of a machining process, optimization of arc welding parameters, and general procedure in optimizing machining operations sequence.
UNIT V	**RELIABILITY:** Concepts of Engineering Statistics, risk and reliability, probabilistic approach to design, reliability theory, design for reliability, numerical problems, hazard analysis.

TEXT BOOKS	
1	Optimization for Engineering Design – Kalyanmoy Deb, PHI Publishers
2	Ray C. Johnson, "Optimum Design of Mechanical Elements", 2nd Ed., John Wiley & sons, Inc., New York, 1980
3	Wilde, D.J., "Optimum Seeking Methods", Prentice Hall, Englewood Cliffs, New Jersey, 1964
REFERENCE BOOKS	
1	Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers
2	Multi objective Genetic algorithms - Kalyanmoy Deb, PHI Publishers
3	Optimal design – Jasbir Arora, Mc Graw Hill (International) Publishers

4	An Introduction to Reliability and Maintainability Engineering by CE Ebeling, Waveland Printers Inc., 2009
5	Reliability Theory and Practice by I Bazovsky, Dover Publications, 2013.

SYLLABUS

M.Tech I Year II Semester **R19** **Specialization: CAD/CAM**

COMPUTER GRAPHICS

Course Category	Professional Core		
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment**	40
		Semester End Examination	60
		Total Marks	100

COURSE OBJECTIVES	
1	To discuss the basic principles of computer graphics primitives.
2	To demonstrate transformation,clipping and viewing in 2D graphics and learn projections ,transformations and visible surface detections 3D graphics.
3	To understand the different algorithms for removing lines, surfaces and shading the objects
4	To introduce the concepts of 3D primitives.
5	To understand the fundamental elements in multimedia and technologies behind multimedia applications.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Analyze algorithms for various graphics shapes such as ellipse , circle by understanding the fundamentals of computer graphics	k4
CO2	Analyze basic concepts of representing 3D objects	k4
CO3	Develop different algorithms for removing lines ,surfaces and developing algorithms for shading.	k5
CO4	Illustrate the various Visual surface detection Methods in 3D Graphics	k4
CO5	Summarize the key concepts in current multimedia technology	k2

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes

(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	3	3	3	1
CO2	3	3	3	2
CO3	3	3	3	2
CO4	2	3	2	3
CO5	2	1	3	3

COURSE CONTENT	
UNIT I	**Raster scan graphics:** Raster scan and random scan architecture, Line drawing algorithms – DDA & Bresenham algorithms, circle generation, general function rasterization, displaying lines, characters and polygons. **Filling algorithms:** polygon filling, edge fill algorithm, seed fill algorithm, fundamentals of antialiasing and half toning.
UNIT II	**Line CLIPPING:** Simple visibility algorithm, Cohen-Sutherland subdivision line clipping algorithm, midpoint sub division algorithm. **Polygon clipping:** polygon clipping, reentrant polygon clipping – Sutherland – Hodgeman algorithm, character clipping, 3D- clipping.
UNIT III	**Rendering:** Hidden line removal algorithms, surface removal algorithms, painters, Warnock, Z-buffer algorithm. **Shading algorithms:** Constant intensity algorithm, Phong's shading algorithm, gourand shading algorithm, Comparison of shading algorithms
UNIT IV	**Computer Animation:** Design of animation sequence, general computer animation functions, raster animation, computer animation language, key frame system, motion specification.
UNIT V	**Introduction to Multimedia:** Introduction, multimedia- systems, technology, architecture, trade-offs, contents, PC, Applications, data compressions, authoring system. **Multimedia Authoring Tools:** Introduction, Types of authoring tools, Package based- in card authoring tools, Icon based authoring tools, Time based and presentation tools, object oriented authoring tools, author ware professional for windows (APW).

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.
WEB RESOURCES	
1	http://nptel.ac.in/courses/106102065/
2	http://nptel.ac.in/courses/Webcourse-contents/IIT-Delhi/Computer%20Graphics/csmain.htm
3	http://nptel.ac.in/courses/106106090/

SYLLABUS

M.Tech I Year II Semester **R19** **Specialization: CAD/CAM**

ADVANCED FINITE ELEMENT METHODS

Course Category	Professional Core		
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Exposure to Mechanics, Basics of heat transfer and Mathematics	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To study the basic principles of finite element analysis procedure.
2	To study the analysis of 1-D structures, Trusses and Beams.
3	To study the analysis of 2-D structures.
4	To study the analysis of 3-D structures and 1-D, 2-D heat conduction problems
5	To study the procedure for dynamic analysis of structures.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Analyze the structures by using the various methods to calculate stiffness.	k4
CO2	Analyze the axial bar, trusses and Beams structures .	k4

CO3	Evaluate the stiffness matrix of 2-D structures by using CST, LST, Isoparametric, quadrilateral element.	k5
CO4	Evaluate the stiffness matrix of 3-D structures and 1-D, 2-D heat conduction slabs.	k5
CO5	Evaluate the mass matrix and natural frequencies of dynamic systems.	k5

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes

(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	3	3	3	1
CO2	3	3	3	1
CO3	3	3	3	2
CO4	3	3	3	2
CO5	3	3	3	2

COURSE CONTENT	
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, basic element shapes, interpolation function, Virtual energy principle, Rayleigh – Ritz method, properties of stiffness matrix, treatment of boundary conditions, shape functions and 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. Finite element modeling of Axi-symmetric solids subjected to Axi-symmetric loading with triangular elements.
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 Hil.
REFERENCE BOOKS	
1	The Finite Element Methods in Engineering / SS Rao / Pergamon.
2	Introduction to Finite Elements in Engineering, Chandrupatla, Ashok and Belegundu, Prentice – Hall
3	A First Course in the Finite Element Method/Daryl L Logan/Cengage Learning/5th Edition
4	Finite Element Method – Krishna Murthy / TMH 6. Finite Element Analysis – Bathe / PHI
WEB RESOURCES	
1	https://nptel.ac.in/courses/112106130/
2	http://www.nptelvideos.in/2012/12/advanced-finite-elements-analysis.html
3	http://www.nptelvideos.com/course.php?id=763

SYLLABUS

M.Tech I Year II Semester **R19** **Specialization: CAD/CAM**

QUALITY ENGINEERING IN MANUFACTURING

(ELECTIVE III)

Course Category	Professional Elective		
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment**	40
		Semester End Examination	60
		Total Marks	100

COURSE OBJECTIVES	
1	To understand quality engineering in design of production processes
2	To study about tolerancing and tolerance design.
3	To understand need for ANOVA .
4	To study about Orthogonal arrays.
5	To learn about six sigma DMAIC methodology ,its tools and applications

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Apply different approaches and techniques to improve product and process quality	k3

CO2	Apply parameter and tolerance design for someof the case studies	k3
CO3	To analyze ANOVA for four level and multi level factors	k4
CO4	To analyze Orthogonal arrays for Designing and Experimentation	k4
CO5	To create logical structured approach by six sigma methodology to improve business processes	k6

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes

(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	3	3	3
CO2	3	3	3	2
CO3	2	3	3	2
CO4	2	2	3	2
CO5	3	3	3	3

COURSE CONTENT	
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 fbr multiple components. Parameter and Tolerance Design: Introduction to parameter design, signal to noise ratios, Parameter design strategy, some of the case studies on parameter and tolerance designs.

UNIT III	**ANALYSIS OF VARIANCE (ANOVA):** Introduction to ANOVA, Need for ANOVA, NO-way ANOVA, One-way ANOVA, Two-way ANOVA, Critique of F-test, ANOVA for four level factors, multiple level factors.
UNIT IV	**ORTHOGONAL ARRAYS:** Typical test strategies, better test strategies, efficient test strategies, steps in designing, conducting and analyzing an experiment. Interpolation of Experimental Results: Interpretation methods, percent contributor, estimating the mean.
UNIT V	**SIX SIGMA AND THE TECHNICAL SYSTEM:** Six sigma DMAIC methodology, tools for process improvement, six sigma in services and small organizations, statistical foundations, statistical methodology.

TEXT BOOKS	
1	Design and Analysis of Experiments by Douglas C. **Montgomery**
2	Taguchi Techniques for Quality Engineering / Phillip J. Ross / McGraw Hill/ Intl. II Edition, 1995.
REFERENCE BOOKS	
1	Quality Engineering in Production systems by G. Taguchi, A. Elsayed et al, McGraw Hill Intl. Pub1989.
2	Taguchi Methods explained: Practical steps to Robust Design / Papan P. Bagchi *I* Prentice Hall Pvt. Ltd., New Delhi.
WEB REFERENCES	
1	http://nptel.ac.in/courses/112107142/15
2	http://nptel.ac.in/courses/112107142/12

SYLLABUS

M.Tech I Year II Semester **R19** **Specialization: CAD/CAM**

FRACTURE MECHANICS

(ELECTIVE III)

Course Category	Professional Elective		
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Exposure to Engineering Mechanics and Applied Mathematics	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To study the fracture behaviour in ductile and brittle materials.
2	To study stress concentration, critical stress and R-curves.
3	To learn about the parameters of the crack tip openings.
4	To learn about fatigue cycles and predict the life.
5	To study about creep in the materials and creep fatigue interactions.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	To analyze the fracture behaviour in ductile and brittle materials.	k4

CO2	Analyze the stress concentration and critical stress factors	k4
CO3	Evaluate the parameters of the crack tip opening.	k5
CO4	Determine the fatigue limits and propagation of fracture.	k5
CO5	Determine the creep damage and creep deformation maps.	k6

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes

(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	3	3	3	1
CO2	3	3	3	2
CO3	3	3	3	2
CO4	3	3	3	2
CO5	2	1	1	2

COURSE CONTENT	
UNIT I	**Introduction:** Prediction of mechanical failure. Macroscopic failure modes; 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 fracture energy, R. Modification for ductile materials, loading conditions. Concept of R curves. **Linear Elastic Fracture Mechanics, (LEFM).** Three loading modes and 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 of alternative 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 Cycle Fatigue, 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:** The evolution of creep damage, primary, secondary and 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	1. T.L. Anderson, Fracture Mechanics Fundamentals and Applications, 2nd Ed. CRC press,
2	G. E. Dieter, Mechanical Metallurgy, McGraw Hill, (1988)
REFERENCE BOOKS	
1	1. B. Lawn, Fracture of Brittle Solids, Cambridge Solid State Science Series 2nd ed1993.
2	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
Web References	
1	https://nptel.ac.in/courses/112106065/
2	https://nptel.ac.in/syllabus/112106065/

SYLLABUS

M.Tech I Year II Semester **R19** **Specialization: CAD/CAM**

FLEXIBLE MANUFACTURING SYSTEMS

(ELECTIVE - III)

Course Category	Professional Elective		
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment**	40
		Semester End Examination	60
		Total Marks	100

COURSE OBJECTIVES	
1	To understand the Evolution of manufacturing systems and its applications.
2	To study about different types of Flexible manufacturing systems.
3	To understand the different process layouts and their applications in industries
4	To learn the different material handling systems in various industrial applications.
5	To analyze the design of Flexible manufacturing systems and also various case studies.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Illustrate the different manufacturing systems and their characteristics	k2

CO2	Apply the different flexible manufacturing systems to the industrial applications	k3
CO3	Analyze the different process layouts and their salient features	k4
CO4	Explain different material handling Systems and their applications	k5
CO5	Evaluate design of flexible manufacturing systems and their case studies.	k5

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes

(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	3	3	3	2
CO2	2	3	2	2
CO3	2	3	2	2
CO4	2	3	3	2
CO5	2	3	2	3

COURSE CONTENT	
UNIT I	**Understanding of FMS:** Evolution of Manufacturing Systems, Definition, objective and Need, Components, Merits, Demerits and Applications Flexibility in Pull and Push type
UNIT II	**Classification of FMS Layout:** Layouts and their Salient features, Single line, dual line, loop, ladder, robot centre type etc.
UNIT III	**Processing stations:** Salient features Machining Centers, Turning centre, Coordinate measuring machine (CMM), Washing/ Deburring station
UNIT IV	**Material Handling System:** An introduction, Conveyor, Robots, Automated Guided Vehicle (AGV), Automated Storage Retrieval System (ASRS) Management technology: Tool

	Management, tool magazine, Tool preset, identification, Tool monitoring and fault detection, routing, Production Planning and Control, Scheduling and loading of FMS
UNIT V	**Design of FMS:** Performance Evaluation of FMS, Analytical model and Simulation model of FMS Case studies: Typical FMS problems from research papers

TEXT BOOKS	
1	William W Luggen, "Flexible Manufacturing Cells and System" Prentice Hall of Inc New Jersey, 1991
2	Reza A Maleki "Flexible Manufacturing system" Prentice Hall of Inc New Jersey, 1991 3. John E Lenz "Flexible Manufacturing" marcel Dekker Inc New York ,1989.
REFERENCE BOOKS	
1	Groover, M.P "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall
WEB RESOURCES	
1	http://www.ignou.ac.in/upload/UNIT6-55.pdf
2	https://nptel.ac.in/courses/112103174/module1/lec2/3.html

SYLLABUS

M.Tech I Year II Semester **R19** **Specialization: CAD/CAM**

MECHANICS AND MANUFACTURING METHODS OF COMPOSITES

(ELECTIVE - IV)

Course Category	Professional Elective		
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	MMS, MOS	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To learn about the various types of composites and their applications.
2	To study about the Micromechanics and Coordinate transformations of the composite materials.
3	To learn about Elastic behavior and strength of unidirectional composites
4	To learn about the laminated composite plates and their analysis.
5	To study about various Manufacturing methods of composites.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Illustrate the various types of composites and their applications.	k3
CO2	Analyze the Micromechanics and Coordinate transformations of the composite materials.	k4

CO3	Summarize the Elastic behavior and strength of unidirectional composites	k3
CO4	Analyze the laminated composite plates and their analysis.	k4
CO5	Explain the various Manufacturing methods of composites.	k2

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes

(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	3	2	-	3
CO2	3	2	-	3
CO3	3	1	-	3
CO4	3	1	-	3
CO5	3	2	-	3

COURSE CONTENT	
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, Thermosetts, Metal matrix and ceramic composites.
UNIT II	Micromechanics: Unidirectional composites, constituent materials and properties, elastic properties of a lamina, properties of typical composite materials, laminate characteristics and configurations. Characterization of composite properties. Coordinate transformations: Hooke's law for different types of materials, Hooke's law for two dimensional unidirectional lamina, Transformation of stress and strain, Numerical examples of stress strain transformation, Graphic interpretation of stress – strain relations. Off

	- axis, stiffness modulus, off - axis compliance.
UNIT III	Elastic behavior of unidirectional composites: Elastic constants of lamina, relationship between engineering constants and reduced stiffness and compliances, analysis of laminated composites, constitutive relations. Strength of unidirectional lamina: Micro mechanics of failure, Failure mechanisms, Strength of an orthotropic lamina, Strength of a lamina under tension and shear maximum stress and strain criteria, application to design. 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, moulding methods, filament winding, hand layup, pultrusion, RTM.

TEXT BOOKS	
1	1. R. M. Jones, Mechanics of Composite Materials, Mc Graw Hill Company, New York, 1975.
2	2. Engineering Mechanics of Composite Materials by Isaac and M.Daniel, Oxford University Press, 1994.
REFERENCE BOOKS	
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 Nostrand Rainfold, New York, 1969.
WEB RESOURCES	
1	https://nptel.ac.in/courses/112104221/
2	https://nptel.ac.in/courses/112104221/31
3	http://nptel.ac.in/courses/112104229/38
4	https://nptel.ac.in/courses/112104161/
5	https://nptel.ac.in/courses/112104221/11
6	https://nptel.ac.in/courses/105108124/pdf/Lecture_Notes/LNm4.pdf

SYLLABUS

M.Tech I Year II Semester **R19** **Specialization: CAD/CAM**

RAPID PROTOTYPING

(ELECTIVE - IV)

Course Category	Professional Elective		
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Basics of production technology & manufacturing techniques	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	Learn fundamentals of rapid prototyping process & its applications.
2	Learn software aspects of rapid prototyping including product modeling.
3	Learn different processing techniques in liquid based rapid prototyping systems.
4	Learn different processing techniques in solid based rapid prototyping systems.
5	Learn some advances in rapid prototyping systems.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Describe the fundamentals & applications of rapid prototyping process.	k2
CO2	Apply modeling, data conversion concepts & implement different algorithms associated with STL file errors.	k3

CO3	Select the appropriate fabrication technique in liquid based rapid prototyping systems.	k4
CO4	Select the appropriate fabrication technique in solid based rapid prototyping systems.	k4
CO5	Solve resolution, accuracy, hardening issues in rapid prototyping processes	k5

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes

(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	2	1	1
CO2	2	3	1	2
CO3	2	1	1	3
CO4	2	1	1	3
CO5	2	1	1	2

COURSE CONTENT	
UNIT I	**Rapid Prototyping** - Historical Development - Applications: Design, Planning, Manufacturing and Tooling - Applications: Automotive, Jewelry, Coin and Bio-Medical - Fundamentals of Rapid Prototyping, Design Process - Rapid Prototyping Process Chain
UNIT II	**Subsystems of RP Machine** - Subsystems of RP machine o Optical System - Mechanical Scanning System - Computer Interfacing hardware, DAQs o Signal Flow, 3D Model to RP Prototype - Introduction to 3D Modeling Softwares (Auto-CAD, PROE, CATIA, IDEAs etc.) - Slicing and Scan Path Generation Algorithms - Data Conversion and Transmission - File Formats, IGES, STL - Preprocessing and Post-processing
UNIT III	**Liquid Based Rapid Prototyping Systems** - Materials - Stereolithography - Solid Ground

	Curing - Solid Object UV (Ultra-Violet) Printer - Two Laser System - Micro-stereolithography.
UNIT IV	**Solid Based Rapid Prototyping Systems** - Materials - LOM (Laminated Object Manufacturing) System - FDM (Fuse Deposition Modeling) System - Multi-Jet Modeling (MJM) System - Model Maker and Pattern Master - Shape Deposition Manufacturing Process
UNIT V	**Advances in RP Systems and Case Studies** - Advances in RP: Resolution & Accuracy issues, Integrated Hardening Process, Two Photon Process for Micro/Nano Fabrication, Reverse Engineering Process and Applications. • Case Study: Wind-Tunnel Testing with RP Models • Case Study: Investment Casting with RP

TEXT BOOKS	
1	Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010.
2	Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003
REFERENCE BOOKS	
1	Rapid Prototyping and Engineering applications: A tool box for prototype development, Liou W. Liou, Frank W. Liou, CRC Press, 2007.
2	Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006. 3. Hilton P.D. and Jacobs P.F., "Rapid Tooling: Technologies and Industrial Applications", CRC press, 2000.
WEB RESOURCES	
1	nptel.ac.in/courses/112104204/47
2	nptel.ac.in/courses/112107078/37
3	nptel.ac.in/syllabus/112104156/

SYLLABUS

M.Tech I Year II Semester **R19** **Specialization: CAD/CAM**

INTELLIGENT MANUFACTURING SYSTEMS

(ELECTIVE - IV)

Course Category	Professional Elective		
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Basics of production technology & manufacturing techniques	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To Understand the basic fundamentals of computer aided design and manufacturing.
2	To study the components of knowledge based systems.
3	To learn about Concept of Artificial Intelligence and its applications in manufacturing.
4	To learn about automated process planning .
5	To study about Group Technology in Automated Manufacturing System.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Understand the concepts of computer integrated manufacturing systems and manufacturing communication systems	k2

CO2	Identify various components of knowledge based systems	k2
CO3	Analyze the concepts of artificial intelligence, Artificial Neural Networks and it's applications in Manufacturing.	k4
CO4	Select the Systems for Process Planning and manufacturing equipment using knowledge based system .	k2
CO5	Apply various methods to solve group technology problems and demonstrate the structure for knowledge based system for group technology	k3

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes

(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	-	3	2	2
CO2	-	3	2	2
CO3	2	3	2	3
CO4	-	3	2	3
CO5	2	3	2	3

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

UNIT II	**COMPONENTS OF KNOWLEDGE BASED SYSTEMS** - Basic Components of Knowledge Based Systems, Knowledge Representation, Comparison of Knowledge Representation Schemes, Interference Engine, Knowledge Acquisition.
UNIT III	**MACHINE LEARNING** - Concept of Artificial Intelligence, Conceptual Learning, Artificial Neural Networks - Biological Neuron, Artificial Neuron, Types of Neural Networks, Applications in Manufacturing.
UNIT IV	**AUTOMATED PROCESS PLANNING** - Variant Approach, Generative Approach, Expert Systems for Process Planning, Feature Recognition, Phases of Process planning. Knowledge Based System for Equipment Section (KBSES)-Manufacturing system design. Equipment selection problem, Modeling the Manufacturing Equipment Selection problem, problem solving approach in KBSES, Structure of the KRSES.
UNIT V	**GROUP TECHNOLOGY:** Models and Algorithms Visual Method, Coding Method, Cluster Analysis Method, Matrix Formation - Similarity Coefficient Method, Sorting-based Algorithms, Bond Energy Algorithm, Cost Based method, Cluster Identification Method, Extended CI Method. Knowledge Based Group Technology - Group Technology in Automated Manufacturing System. Structure of Knowledge based system for group technology (KBSCIT) — Data Base, Knowledge Base, Clustering Algorithm.

TEXT BOOKS	
1	Intelligent Manufacturing Systems/ Andrew Kusiak/Prentice Hall.
2	Artificial Neural Networks/ Yagna Narayana/ PHI/2006
3	Automation, Production Systems and CIM / Groover M.P./PHI/2007
REFERENCE BOOKS	
1	CAD/CAM/CIM by P. Radhakrishnan, S.Subramanyan, V.Raju, New age Publications
2	Hamid R. Parsaei and Mohammad Jamshidi, "Design and Implementation of Intelligent Manufacturing Systems", PHI, 2009.
WEB RESOURCES	
1	http://www.nptelvideos.in/2012/11/intelligent-systems-and-control.html
2	https://www.researchgate.net/publication/260918138_The_Intelligent_Manufacturing_Systems
3	https://link.springer.com/chapter/10.1007/978-1-84996-119-6_1

SYLLABUS

M.Tech I Year II Semester **R19** **Specialization: CAD/CAM**

ADVANCED CAM LAB

Course Category	Lab Course		
Course Type	Laboratory	**L-T-P-C**	0-0-4-2
Prerequisites		**Internal Assessment**	40
		Semester End Examination	60
		Total Marks	100

COURSE OBJECTIVES	
1	To carry out the metal removal processes on lathe and milling machines

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Describe the metal removal processes on lathe and milling machines	k2

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes

(1 – Low, 2 - Medium, 3 – High)

	PO1	PO2	PO3	PSO1
CO 1	1	2	2	2

List of experiments:

CNC – Lathe

1. Stock removal Cycle
2. Contour Turning Cycle
3. Grooving Cycle
4. Threading Cycle
5. Drilling Cycle

CNC – Milling

1. Linear And Circular Interpolation
2. Circular Pocketing
3. Rectangular Pocketing
4. Peck Drilling
5. Contour milling

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M.Tech II Year I Semester **R19** **Specialization: CAD/CAM**

GEOMETRIC MODELING

Course Category	Professional Core		
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment**	40
		Semester End Examination	60
		Total Marks	100

COURSE OBJECTIVES	
1	To learn about fundamental concepts of parametric and geometric forms of curves and surface schemes
2	To study the modeling of curves using cubic splines and Bezier curves
3	To understand the properties, derivatives and modeling of B-spline curves.
4	To study the principles of geometrical modelling of curves and surfaces schemes.
5	To understand the concepts of solid modeling techniques along with wire frame modeling

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Explain the coordinate system for the development of parametric and geometric forms of curves.	k2

CO2	Develop and manipulate the curves like splines and Bezier curves using parametric equations.	k3
CO3	Develop and manipulate the B- splines curves using parametric equations.	k3
CO4	Develop and manipulate the curves and surfaces using parametric equations.	k3
CO5	Develop and manipulate the solid models using different modeling approaches along with wireframe models.	k3

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes

(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	3	3	2	2
CO2	3	3	2	2
CO3	3	3	2	2
CO4	3	3	2	2
CO5	3	3	3	3

COURSE CONTENT	
UNIT I	**Cubic splines –I** Definition, Explicit and implicit equations, parametric equations, Algebraic and geometric form of cubic spline, Hermite cubic spline, tangent vectors, parametric space of a curve, blending functions.
UNIT II	**Cubic Splines-II:** four point form, reparametrization, truncating and subdividing of curves. Graphic construction and interpretation, composite pc curves. **Bezier Curves:** Bernstein basis, equations of Bezier curves, properties, derivatives.

UNIT III	**B-Spline Curves:** B-Spline basis, equations, knot vectors, properties, and derivatives.
UNIT IV	**Surfaces:** Bicubic surfaces, Coon's surfaces, Bezier surfaces, B-Spline surfaces, surfaces of revolutions, Sweep surfaces, ruled surfaces, tabulated cylinder, bilinear surfaces, Gaussian curvature.
UNIT V	**Solids:** Tricubic solid, Algebraic and geometric form. **Solid modeling concepts:** Wire frames, Boundary representation, Half space modeling, spatial cell, cell decomposition, classification problem

TEXT BOOKS	
1	Elements of Computer Graphics by Roger & Adams Tata McGraw Hill.
2	Geometric Modeling by Micheal E. Mortenson, McGraw Hill Publishers
REFERENCE BOOKS	
1	Computer Aided Design and Manufacturing, K.Lalit Narayan, K.Mallikarjuna Rao, MMM Sarcar, PHI Publishers.
2	CAD/CAM by Ibrahim Zeid, Tata McGraw Hill
WEB RESOURCES	
1	http://nptel.ac.in/courses/112102101/44

SYLLABUS

M.Tech II Year I Semester **R19** **Specialization: CAD/CAM**

PRODUCT DESIGN AND DEVELOPMENT

Course Category	Professional Core		
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment**	40
		Semester End Examination	60
		Total Marks	100

COURSE OBJECTIVES	
1	To study the basic concepts of product design and development process and management process over whole product life cycle.
2	To study the methodology for product design, development.
3	To study the applicability of product design and development in industrial applications.
4	To study the key reasons for Investigation of customer needs for new product introduction.
5	To study the basic concepts of cost models for product design, development and production.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Select an appropriate product design and development process for a given application	k4

CO2	Define the components and their functions of product design and development processes and their relationships from concept to customer over whole product lifecycle.	k4
CO3	Select an appropriate standardisation method to analyse, evaluate and apply the methodologies for product design, development .	k5
CO4	Undertake a methodical approach to the management of product development to satisfy customer needs.	k5
CO5	Carry out cost and benefit analysis through various cost models.	k5

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes

(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	3	3	3	2
CO2	3	3	3	1
CO3	3	3	3	2
CO4	3	3	3	2
CO5	3	3	3	2

COURSE CONTENT	
UNIT I	Introduction: Need for IPPD – strategic importance of product development – integration of customer, designer, material supplier and process planner, Competitor and costumer – behavior analysis Understanding customer – promoting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specification.
UNIT II	Concept generation and concept selection: Activity of concept generation – Structured approaches – Five step Method: clarify – Search-Externally and internally – explore systematically – reflect on the solutions and processes – Concept selection – Integral part of PDD process-methodology – benefits.

UNIT III	Product architecture: Implications – Product change – variety – component standardization – product performance – manufacturability Industrial design: Assessing the need for industrial design, impact – design process Integrate design process – assessing the quality of industrial design. ROBUST DESIGN-introduction, various steps in robust design.
UNIT IV	Investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology driven products – user – driven products – assessing the quality of industrial design.
UNIT V	Design for manufacturing: Definition – Estimation of Manufacturing cost – reducing the component costs and assembly costs –cost of supporting production. Minimizing System complexity. Prototyping: Prototype basics – Principles of prototyping – planning for prototypes – Economic analysis. Understanding and representing tasks – baseline project planning – accelerating the project execution.

TEXT BOOKS	
1	Design and Development / Kari T. Ulrich and Steven D. Eppinger /McGraw Hill International Edns. 1999.
2	Effective Product Design and Development / Stephen Rosenthal / Business One Orwin, Homewood, 1992, ISBN, 1-55623-603-4.
REFERENCE BOOKS	
1	David G Ullman, “The Mechanical Design Process.” McGrawhill Inc Singapore 1992 N J M Roozenberg , J Ekels , N F M Roozenberg “ Product Design Fundamentals and Methods .” John Willey & Sons 1995
2	Kevin Otto & Kristin Wood Product Design: “Techniques in Reverse Engineering and new Product Development.” 1 / e 2004 , Pearson Education New Delhi
3	L D Miles “Value Engineering.”
4	Hollins B & Pugh S “Successful Product Design.” Butter worths London.
5	Baldwin E N & Neibel B W “Designing for Production.” Edwin Homewood Illinois