

# **Proposal for M.Tech. ME (CAD/CAM)**

## **1. Preamble**

Due to growing competition at the global level and varying consumer needs, the product life cycle has reduced drastically for many products and hence time to launch a product into the market has become very critical. With the advancement of ITES (IT enabled services), internet and web technology, new sort of challenges have cropped and avenues have been unfolded. To meet the modified targets, companies are working on various strategies like Concurrent Engineering, Simultaneous Engineering, Internet based Manufacturing, Design for Manufacturing & Assembly, etc. Therefore, integration of design and manufacturing along with computational tools has become a necessity for the modern industry in general and product development industry in particular, to minimize the product lead time. The data base and knowledge generated during design phase must be carried forward to the manufacturing phase without time lapse and in an integrated manner. This is also important to eliminate the time lost not only from 'Design to Manufacture' but also to minimize repetitive modeling tasks for the methodologies like process planning, CNC manufacturing, etc.

The mandate of this Institute is also 'IT enables Design and Manufacturing' and hence since its inception, the prime focus of this Institute is to bring a synergy between design and manufacturing through the use of Information Technology. The proposed M. Tech. program in Mechanical Engineering discipline with specialization in CAD/CAM would be in line with the Institute theme and would produce graduate engineers not only with equal competence in design and manufacturing but also efficient in technology usage.

## **2. Objectives**

The conventional educational system allows individual to excel in a limited field. It does not make a student adept in facing challenges due to technology explosion, and more important solving the current societal problems with the proper usage of modern technological solutions. Recent years have also showcased the need of interdisciplinary research as the conventional research fields are rapidly disappearing and new fields are emerging with overlapping knowledge domains.

Proposed M. Tech. in Mechanical Engineering with CAD/CAM specialization provides an opportunity for engineering students to mould themselves to meet the needs, requirements and challenges of product development industries. The proposed program would offer the students to learn design and manufacturing as adopted by the Industry in the present form i.e. in the form of Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) as well as their proper and seamless integration. Design engineers would be ready to understand the challenges thrown during product manufacturing and vice-versa. This would teach them the paradigm of 'Time Compression Technologies' (TCT). Therefore, the long-term goal of this

program is to prepare the students towards integrated design and manufacturing leaning. The program is designed in such a way that it would cater to the need of today's industrial environment.

Further, IIITDM Jabalpur is the only IT institution in the country where Design and Manufacturing is going to establish its benchmark through such interdisciplinary approach.

Institute is also acting on the line of establishing "Design Innovation Center" and "Manufacturing Innovation Center" within in its premises and with state of the art facilities. Such environments would give an exciting challenging opportunity to explore rare fields of research and profession to grow with. The programme envisages developing adequate facility soft facilities and laboratory facilities to support the programme. The curriculum of the proposed program is designed in such a way so as to give the students real life exposure on the tools practiced by the industry and facilitate in the professional growth of graduating students.

### **3. Proposed Research Areas:**

The proposed M.Tech. programme would concentrate on developing professionals who would become the real life problem solvers, and who would be effectively trained in modern software and hardware tools like geometric modeling, solid modeling, CNC programming, Additive manufacturing, OGL programming, etc.

### **4. Employment Opportunity:**

The proposed programme would be tailor made to meet the requirements of industry, be it the CAD developers or users. The students would be also adept in both the software and hardware part of modern CAM tools like CNC machining centers, Flexible Manufacturing Centers, Industrial robots, etc. The programme would be a good blend of theoretical teaching and experimental / project work. The healthy synthesis of both would certainly create a strong intellectual base. Based on the experience gained during the course of the programme, the students would have much wider range of employment opportunity.

### **5. Eligibility for Admission**

Candidates with a Bachelor's Degree in Mechanical Engineering, Automobile Engineering, and Production Engineering are eligible for admission to the proposed M. Tech. program. Other conditions would be as per the Institute's PG manual as in practice.

### **6. Conclusion**

The proposed M.Tech. Programme is line with the manifesto of the Institute. The teaching and research work in an integrated environment of IT, Design and Manufacturing would create a new path not only in interdisciplinary research but would also meet the demand of the industry. Hence, by introducing the proposed

programme, the Institute and the discipline would be benefited and be able to establish a leadership and unique academic environment.

## 7. Proposed Curriculum

The proposed curriculum is as given below:

<b>Semester I (20 Credits)</b>		
1.	Professional and Communication Skills	1-0-2-2
2.	Analytical Methods in Engineering (Compulsory)	3-0-0-4
3.	Computer Aided Design (Compulsory)	3-0-0-4
4.	NC-CNC Machine Tools and Programming	2-0-2-4
5.	Elective I	3-0-0-4 / 2-0-2-4
6.	Geometric Modeling Lab (GML) (Compulsory)	0-0-2-2
<b>Semester II (18/20 Credits)</b>		
1.	Elective II	3-0-0-4 / 2-0-2-4
2.	Elective III	3-0-0-4 / 2-0-2-4
3.	Elective IV	3-0-0-4 / 2-0-2-4
4.	Geometric Programming Lab (GPL) (Compulsory)	0-0-2-2
5.	M.Tech Thesis	0-0-0-4
<b>Semester III (18/20 Credits)</b>		
1.	M.Tech Thesis	0-0-0-16
2.	Graduate Seminar I	0-0-0-2
<b>Semester IV (18 Credits)</b>		
1.	M.Tech Thesis	0-0-0-16
2.	Graduate Seminar II	0-0-0-2

### List of Electives

1.		Computer Aided Geometric Design
2.		Computational Geometry for Engineers
3.	ME 613	Engineering Optimization
4.		Finite Element Methods
5.		Computational Fluid Dynamics
6.	ME 656	Rapid Product Development Technologies
7.		Advanced Manufacturing Processes and Technologies
8.		Flexible Manufacturing Systems
9.		Computer Integrated Manufacturing Systems
10.		Computer Aided Process Planning
11.		Manufacturing Automation
12.		Industrial Robotics
13.		Design of Mechanisms and Manipulators
14.		Micro Electromechanical Systems (MEMS)
15.		Manufacturing Metrology
16.		Design of Experiments
17.		Advanced Machining Processes
18.		Precision Manufacturing
19.		Metal Forming
20.		Fuzzy Logic and Neural Networks
21.		Smart Materials and Structures
22.		Automotive Design

## Course Contents

### ME 640 Analytical Methods in Engineering

1. Solution methods for Ordinary Differential Equations (ODEs)
  - First and n-th order differential equations
2. Partial Differential Equations PDEs
  - Classification
  - Transformations to Canonical forms for Hyperbolic, Elliptic and Parabolic equations
3. Concepts in approximate solutions of differential equations
  - Space of Functions, Inner product spaces
  - Orthogonal projections
  - Norm
  - Projection of a Function onto an Orthogonal set
  - Gram-Schmidt Orthogonalization and Orthonormal set
4. Analytical series solutions of PDEs
  - Separation of Variables
  - Extension of Separation of Variables methodology by Method of Superposition
  - Rectangular coordinate system
  - Cylindrical coordinate system (Bessel function)
  - Spherical coordinate system (Legendre function)
  - Hyperbolic Equations
  - Elliptic Equations
  - Parabolic Equations
5. Introduction to integral transforms
  - Fourier and Laplace transforms and their applications.
6. Introduction to Numerical Methods
  - Ordinary differential equations and their numerical solutions
  - Euler Methods, Runge-Kutta, Multistep Methods and recent advances
  - convergence and stability
  - Function Approximations and other methods: Chebyshev, Legendre and Bessel functions, Methods of Frobenius, Taylor
7. Applications:
  - Solution of linear and nonlinear ODE and PDE, System of ODEs and PDEs

#### **Text book:**

- J. B. Doshi, Differential equations for scientists and engineers, Narosa.

#### **Reference books:**

- Erwin Kreyszic, Advanced Engineering Mathematics.
- Jain, Iyenger & Jain, Numerical Methods for Scientific Engineering and Computation. New Age International Publishers.

## COMPUTER AIDED GEOMETRIC DESIGN

Overview of Transformations, Projections, Curves, Surfaces and Solids.

Mathematical representations: Intrinsic and Parametric representations, Differential Geometry applied to Curve and Surface Design.

Curves: Non uniform B-Spline (NUB) Curve Models, Rational Curves, Non Uniform Rational B-spline (NURB), Properties of Bezier curves. Manipulation of Curves.

Surfaces: Sculptured, Coons patches, Rational Parametric, NUB, NURB, Polygonal and Quadric Representation of Surfaces. Blending of Surfaces, Curves on Surfaces, Surface with Irregular Boundaries, Manipulation of Surfaces.

Design of curves and surfaces. Analytical and Relational Properties of Curves and Surfaces; Curves and Surfaces in Solids; Plane, Curve, Surface Intersections. Evaluation of some methods of Geometric Modeling.

Mathematical Models of Solids, Constructive Solid Geometry, Boundary Representation, Non-Manifold Geometry, Global Properties of Solid Model.

Applications in product design, analysis and manufacturing e.g. sheet metal working, tool design, mechanical components, etc. Applications in Assembly, Design of volumes. Intersection of surface and interference of volumes, Shape Grammar.

### **Text Books**

1. Michael E. Mortenson, Geometric Modeling, Industrial Press Inc. Edition: 3<sup>rd</sup>

### **Reference Books**

1. Ibraheim Zeid, CAD/CAM: Theory and Practice, TMH. Revised First Edition
2. I.D. Faux and M.J. Pratt, Computation Geometry for Design and Manufacture, John Wiley (Ellis Horwood Ltd.).
3. Choi, B.K, Surface Modeling for CAD/CAM, Elsevier.
4. Farin, Gerald, Curves and Surfaces for Computer Aided Geometric Design – A Practical Guide, Academic Press Inc.
5. Kunwoo Lee, Principles of CAD/CAM/CAE systems, Addison Wesley.
6. Yamaguchi, Curves and Surfaces in Computer Aided Geometric Design, Springer.

## **ME655: NC-CNC Machine Tools and Programming (2-0-2-4)**

**Automation:** Types of automation, Programmed Automation, History of Numerical Control, Components of NC: Punched Tape, MCU, Processing Unit, Axis Designation, NC Motion Control: PTP, Straight cut, Contouring NC Coding System: EIA & ISO format, Application Numerical Control, Advantages, & Disadvantages, Adoptive Control System.

Computer Numerical Control: Block Diagram of CNC operations, Positioning System: Open loop and Closed loop System, Precision in NC Positioning: Control resolution, Accuracy, Repeatability.

Part Programming: Procedures Associated with part programming, Cutting process parameter selection, Process planning issues and path planning, Part programming formats, G & M Codes, Interpolations, Canned Cycles and Subprograms, Tool Compensations etc.

CNC Hardware Basics: Machines Structure, Guidways: Requirements, types and design features, Actuation systems: Ball Screws, Introduction of Servo and Stepper Motors, Feedback devices: Encoder, Optical grating, Resolvers, Inductosyn

Modern CNC Systems: Indexable carbide tools, Modular Tooling & Tool Presetting, Machining Centers, Automatic tool changers

Computer Aided Part Programming: APT Programming, Part Program Generation through ProE/DelCAM, Post Processors Computations for part programming: Segmentations of free form curves, Consideration for INTOL and OUTTOL, Part programming for Bezier and B-spline Curves, Generating part program from CAD drawings.

### **Text Books:**

1. Groover M.P., Automation, Production Systems, and Computer-Integrated Manufacturing”, Pearson Education.
2. S K SINHA, “CNC Programming”, Galgotia Pubs.

### **Reference Books:**

1. Chang, Wysk and Wang, Computer Aided Manufacturing, Prentice Hall International. 3rd Edition
2. Kochan D., CAM: Developments in Computer Integrated Manufacturing System, Springer Verlag.
3. Chang, T.C., An Introduction to Automated Process Planning Systems, Prentice Hall International.
4. Rao P N., “CAD/CAM Principles and Practice”, Tata McGraw-Hill
5. Kundra, Rao and Tiwari, Numerical Control and CAM, T
6. Robert Quesada, T. Jeyapoovan, “Computer Numerical Control : Machining Center and Turning Centers”, Tata McGraw-Hill
7. CNC Machine Manuals

### **Geometric Modeling Lab (GML)**

This lab oriented course would be based on generic CAD software. The objective of the course is to train the students in Geometric modeling in any CAD environment like ProE / CATIA / NX/ Unigraphics / Solid Works. The focus would be on training the students on customization, programming for design automation, Macro writing, etc. The students would be exposed to different modules like die design, mechanisms, manufacturing modeling, etc.

### **Geometric Programming Lab (GPL)**

The objective of this course is to train the students on CAD development front and to expose them to the problems faced by CAD developers. The course comprises programming exercises/ assignments on Computer Aided Geometric Design, Computer Aided Engineering, Finite Element Analysis, Rapid Product Development Technologies, File formats, data exchange, etc. using OpenGL, MATLAB, C, C++.