

# COMPUTER AIDED DESIGN

ENME 253

**Lecture** : 3  
**Tutorial** : 1  
**Practical** : 1.5

**Year** : II  
**Part** : II

## Course Objectives:

This course covers the theoretical concepts of geometric modeling, mathematical foundations of curves, surfaces, and solids, as well as practical applications. Students will become acquainted with various computer software for creating, modifying, and analyzing engineering design and familiarize themselves with various types of commercial software.

- 1 Introduction (3 hours)**
  - 1.1 Definitions of computer aided design (CAD), computer aided manufacturing (CAM) and computer aided engineering (CAE), history of CAD/CAM development
  - 1.2 CAD systems and software modules: Part module, assembly module, draft module, analysis module
  - 1.3 Applications for CAD in engineering
  
- 2 Geometric Modeling Fundamentals (6 hours)**
  - 2.1 Geometry and topology
  - 2.2 Coordinate systems (Cartesian, cylindrical, spherical), review of vector algebra
  - 2.3 Parametric and non-parametric curves
  - 2.4 Types of geometric modeling: Wire frame- surface and solid modeling
  
- 3 Mathematical Representation of Curves (12 hours)**
  - 3.1 Parametric representation of analytic curves: Lines, circles, ellipses, parabolas, hyperbolas, conics
  - 3.2 Parametric representation of synthetic curves: Hermite, Bezier, B-Spline, Rational curves, Non-Uniform Rational B-Spline (NURBS) curve (Only basic treatment)
  - 3.3 Curve manipulation: Evaluating points on curves, blending, segmentation, trimming, intersection

**4 Representation of Surfaces and Solids (12 hours)**

- 4.1 Surface entities (Only basic treatment): Plane surface, ruled surface, surface of revolution, tabulated cylinder, Bezier surface, b-spline surface, coons patch, fillet surface, offset surface
- 4.2 Fundamentals of solid modeling: Set theory, Boolean operations (union, intersection, subtraction), half-spaces
- 4.3 Solid modeling techniques: Boundary representation (B-Rep), Euler-Poincare law, winged edge data structure, constructive solid geometry (CSG)

**5 CAD Modeling Techniques (3 hours)**

- 5.1 Feature-based modeling, assembly and constraints, extrusion, revolutions, sweeps, lofting, blending
- 5.2 Dimensioning and tolerance
- 5.3 Manipulation and editing of entities: Selection methods (e.g., dragging, clipping, trimming, stretching, offsetting, pattern, copying, deleting, regenerating, measuring)

**6 CAM and Recent Technology (9 hours)**

- 6.1 Computer aided manufacturing (CAM): Integration of CAD and CAM, automation in manufacturing execution system (MESS)
- 6.2 CAD/CAM data exchange: IGES, STEP, STL, DXF, PDES, ACIS, parasolid
- 6.3 Fundamentals of machine programming: Computer numeric control (CNC), automatically programmed tools (APT)
- 6.4 Rapid prototyping and manufacturing: Stereo lithography, solid ground curing, 3D printing
- 6.5 Virtual engineering: Virtual design, cloud based CAD, generative design, advanced simulation and analysis, virtual and augmented reality

**Tutorial (15 hours)**

1. CAD software and their applications
2. Different types of geometric models
3. Curve manipulation exercises
4. Boolean operations and solid modeling techniques
5. Feature-based modeling techniques: Extrusion, revolution, lofting, sweeping
6. Basics of CNC programming: G-codes and M-codes

**Practical (22.5 hours)**

1. Study of various software for engineering design and drafting
2. Study of CATIA/Solidworks and its tools
3. Exercise on 2D drawing
4. Exercise on pad and groove
5. Exercise on shaft, mirror and array
6. Exercise on threading, bores and tappings

7. Exercise on part assembly
8. Exercise on drafting
9. Exercise on surface modeling
10. Exercise on kinematics

### Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

| Chapters     | Hours     | Marks distribution* |
|--------------|-----------|---------------------|
| 1 and 2      | 9         | 10                  |
| 3            | 12        | 20                  |
| 4            | 12        | 20                  |
| 5 and 6      | 12        | 10                  |
| <b>Total</b> | <b>45</b> | <b>60</b>           |

\* There may be minor deviation in marks distribution.

### References

1. Zeid, I., Sivasubramanian, R. (2009). CAD / CAM: Theory and Practice (2nd ed.). McGraw-Hill.
2. Lee, K. (1999). Principles of CAD/CAM/CAE (1st ed.). Pearson.
3. Newman, W.M., Sproull, R.F. (1979). Principles of interactive Computer Graphics. (2nd ed.). McGraw-Hill.
4. Groover, M. (2003). CAD/CAM: Computer-Aided Design and Manufacturing (1st ed.). Pearson.
5. McMahon, C., Browne, J. (1999). CAD/CAM: Principles, Practice and Manufacturing Management (2nd ed.). Prentice Hall.