GUJARAT TECHNOLOGICAL UNIVERSITY

MECHANICAL ENGINEERING (19)
COMPUTER AIDED DESIGN
SUBJECT CODE: 2161903
B.E. 6th SEMESTER

Type of course: Under Graduate

Prerequisite: None.

Rationale: Computers have become inevitable in today era and find their application in various stages of product development. This course intends to introduce students to use of computers in the phases of product design viz. conceptualization, geometric modelling, graphical representation and finite element analysis.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks			Practical Marks			
L	T	P	C	ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Introduction:** A typical product cycle, CAD tools for the design process of product cycle, CAD / CAM system evaluation criteria, Input / Output devices; Graphics Displays: Refresh display, DVST, Raster display, pixel value and lookup table, estimation of graphical memory, LCD, LED fundamentals. Concept of Coordinate Systems: Working Coordinate System, Model Coordinate System, Screen Coordinate System. Line and Curve generation algorithm: DDA, Bresenham's algorithms. Graphics exchange standards and Database management systems.	**6**	**15%**
2	**Curves and Surfaces:** Parametric representation of lines: Locating a point on a line, parallel lines, perpendicular lines, distance of a point, Intersection of lines. Parametric representation of circle, Ellipse, parabola and hyperbola. Synthetic Curves: Concept of continuity, Cubic Spline: equation, properties and blending. Bezier Curve: equations, properties; Properties and advantages of B-Splines and NURBS. Various types of surfaces along with their typical applications.	**7**	**20%**
3	**Mathematical representation of solids:** Geometry and Topology, Comparison of wireframe, surface and solid models, Properties of solid model, properties of representation schemes, Concept of Half-spaces, Boolean operations. Schemes: B-rep, CSG, Sweep representation, ASM, Primitive instancing, Cell Decomposition and Octree encoding.	**4**	**10%**
4	**Geometric Transformations:** Homogeneous representation; Translation, Scaling, Reflection, Rotation, Shearing in 2D and 3D; Orthographic and perspective projections. Window to View-port transformation.	**5**	**10%**

5	**Finite Element Analysis:** Review of stress-strain relation and generalized Hooke's Law, Plane stress and Plane strain conditions; Concept of Total Potential Energy; Basic procedure for solving a problem using Finite Element Analysis. 1-D Analysis: Concept of Shape function and natural coordinates, strain - displacement matrix, derivation of stiffness matrix for structural problems, properties of stiffness matrix. 1-D structural problems with elimination and penalty approaches, 1-D thermal and fluid problems. Trusses and Beams: Formulation of stiffness matrix, simple truss problems to find displacement, reaction and stresses in truss members. Structural analysis using Euler-Bernoulli beam element. Higher Order Element: CST element stiffness matrix formulation, shape functions and applications of Quad and axisymmetric elements.	**21**	**45%**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
10	**15**	**15**	**10**	**10**	**10**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Ibrahim Zied, CAD / CAM: Theory and Practice, McGraw-Hill
2. Hearn E J and Baker M P, Computer Graphics, Pearson.
3. Chandrupatla T A and Belegundu A D, Introduction to Finite Elements in Engineering, PHI.
4. Logan D, A First Course in the Finite Element Method, Cengage.

Course Outcome:

After learning the course the students should be able to:

1. Understand and appreciate use of computer in product development.
2. Apply algorithms of graphical entity generation.
3. Understand mathematical aspects of geometrical modelling.
4. Understand and use finite element methods for analysis of simple components.

List of Experiments:

1. Prepare a programme for plotting lines and curves using algorithms learned.
2. Introductory exercise for 3-D modelling.
3. Exercise for advanced 3-D modelling.
4. Exercise for 3-D editing options.
5. Exercise for Assembly modelling.
6. Exercise for surface modelling.
7. Introductory exercise for finite element analysis.

8. Exercise for FEA of 1-D structural problems.
9. Exercise for FEA of trusses.
10. Exercise for FEA using Beam Element.
11. Exercise for FEA of 1-D thermal problems.
12. Exercise for FEA of 1-D fluid problems.
13. Exercise for FEA of 2-D structural problems.

Design based Problems (DP)/Open Ended Problem:

1. Design a structural component using conventional method, prepare a CAD model, assemble it, synthesize it and perform FEA and compare results of conventional design.

Major Equipment:

1. Computers / Workstations
2. CAD Software
3. FEA Software

List of Open Source Software/learning website:

1. www.nptel.ac.in/

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.