Computer Aided Design   **Faculty I/C – Nikhil Tatke**

Unit I

Q1. Explain the product life cycle of a typical product with the help of a neat sketch.

Q2. Make a table of important design phases.What are the required CAD tools to support various design phases?

Q3. Describe the various design related tasks which are performed by a modern CAD system?

Q4. What are the differences between regular CRTs and flat screen CRTs?

Q5. What are the differences between analog and digital flat panel displays?

Q6. Why does flicker happen in CRTs and not in flat panel displays?

Q7. Why do flat panel displays have problems with viewing angle while CRTs do not?

Q8. For each of the following situations, identify which of the three types of graphics terminals (directed beam refresh, DVST, raster scan) would be most appropriate:

   a) to display large amounts of textual output
   b) to perform kinematic analysis of automobile door hinges
   c) perform stress analysis and display the before and after strain effects at the same time
   d) to display large amount of graphical data on the screen

Q9. Write short notes on the following:

   a) Input devices - cursor control devices, digitizers, keyboard terminals, image scanner, speech control devices, touch panel
   b) Printers and plotters

Unit II

Q1. Explain the various co-ordinate systems available in a typical CAD system. What do you mean by the term 'sketch planes'?

Q2. What do you mean by MCS with respect to co-ordinate systems? CAD/CAM systems have one of the following orientations for MCS: XY - plane horizontal or XY - plane vertical. Sketch each system in 3D plane.

Q3. CAD models can be classified into either 2 ½ D or 3D or a combination of both. Point out various differences between these two types of models.

Q4. If you look around you, there are many objects that serve as good CAD models. Classify each of the following objects as 2 ½ D, composite 2 ½ D, 2 ½ D (axisymmetric) or 3D models :

Keyboard, mouse, mouse cable, computer monitor, printer, chair, computer table, a cell phone, a printer cable, your backpack, trash paper basket, etc.

Q5. What graphics functions are provided in a general purpose graphics package for creating and manipulating pictures? How a 2D scene is modelled in a device co-ordinate?

Q6. Write an algorithm and computer program for scan conversion of a line segment with starting point (x_s, y_s) and end point (x_e, y_e), using Bresenhem's line drawing algorithm.

Q7. Scan convert a circle whose centre is at (10, 20) and radius is 10 units. Write also the algorithm used.

Q8. What is the effect of the following transformations on tangent vector of a curve :

   a) Translating a curve
   b) Reflection through origin

Q9. The vertices of the triangle are (8,1), (7,3), & (6,2). Find a) the reflection about X-axis, and b) the reflection about the line Y = -X.

Q10. A Point P is rotated by 45 [deg] about an axis which is represented by the vector k = $[0.5\ 0.866\ 0.707]^T$ passing through origin. Find the transformation matrix and calculate its determinant?

Q11. Given a point P(2, 4, 8). Find the transformed point P* if P is translated by d = 3i – 4j – 5k and then scaled uniformly by S = 1.5?

Q12. A point is rotated about the Z-axis by two successive angles θ1 and θ2. Show that this is equivalent to rotating the point about the same axis once with any angle θ = θ1 + θ2.

Q13. Write the various steps to find reflection matrix when the axis of reflection is line y = ½(x + 4). The position vectors (2,4,1), (4, 6, 1) and (2, 6, 1) describe the vertices of triangle A, B, C. Just mention the steps involved(no need to do calculations).

(Hint : translate -2 in Y-direction → rotate by $–tan^{-1}(1/2)$ → reflect the triangle through x-axis → transformed position is then rotated and translated back to the original orientation.)

Unit III

Q1. What do you understand by interpolation and approximation splines? Determine and plot the blending functions for Hermite splines? What are the limitations of Hermite splines and how are they removed?

Q2. Find the equation r(u)of a Hermite cubic spline that passes through points (1,2) and (3,4) and whose tangent vectors are the two lines connecting these two points with point (2, 7).

Q3. Why Bezier curves are highly useful and convenient for curve and surface design? What are the design techniques using Bezier curves?

Q4. Prove that the basis functions of the Hermite cubic spline curve are symmetric. What is the consequence of this symmetry?

Q5. For points A=[1,2] and B=[3, 1] with corresponding slopes 60 [deg] and 30 [deg], write the formulation of Hermite cubic spline.

Q6. Find the tangent vector and slope of a parametric general (inclined) parabola with $\alpha=30°$ for two different values of u, 0.5 and 2.0, when the focal distance is 20 mm, by following these two methods and show that the results are same:

a) By using the parametric equations of the general parabola to find directly about MCS.
b) By using the parametric equations of the basic parabola in WCS, and then applying the homogeneous transformation matrix to convert from WCS to MCS.

Q7. If the first segment is formed by Po, P1, P2 and P3 and second segment is formed by P4, P5, P6, P7 and P8, then find the sufficient condition in order to satisfy C^1 continuity of the curve?

Q8. The coordinates of four points are given by $P_0 = [2\ 2\ 0]^T$, $P_1 = [2\ 3\ 0]^T$, $P_2 = [3\ 3\ 0]^T$ and $P_3 = [3\ 2\ 0]^T$. Find the equation of the Bezier curve. Also find points on the curve for u = 0, 0.25, 0.5, 0.5, 1.

Q9. Four vertices of the Bezier polygon are P_0 (1,1), P_1 (2, 3), P_2 (4, 3), P_3 (3, 1). Determine seven points on the Bezier curve.

Q10. Find the equation of a cubic B-spline curve defined by the control points $P_0 = [2\ 2\ 0]^T$, $P_1 = [2\ 3\ 0]^T$, $P_2 = [3\ 3\ 0]^T$ and $P_3 = [3\ 2\ 0]^T$. How does the curve compare with the Bezier curve?

Unit IV

Q1. Briefly explain:

a) Quadric surfaces

b) Superquadric surfaces
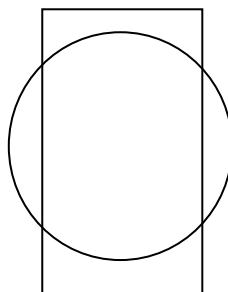
c) Blobby objects

Q2. What are the types of surfaces that CAD/CAM systems use?

Q3. Describe CSG with suitable examples. How 3D objects having translational, rotational, or other symmetry can be modelled? Explain with suitable examples.

Q4. Given the two solids shown below, find S_1 U S_2, S_1 U* S_2, S_1 ∩ S_2, S_1 ∩* S_2, S_1 – S_2, S_1 -* S_2.

S_1 – Block

S_2 – Cylinder

Q5. Differentiate between the following two color models : RGB model, CMY model.

Q6. Write short notes on :

a) R - set

b) Half spaces

c) B - rep

d) Sweep representation

Q7. A valid solid is defined as a point set that has an interior and a boundary. A valid boundary must be in contact with the interior. Sketch a few 2D and 3D solids and identify iS and bS for each one. Is iS always joint for any S? Can bS be disjoint? What is your conclusion?

Q8. Explain the following application commands as used in Pro/E ver. 4.0 :

a) Solid Protrusion

b) Thin Protrusion

c) Extrude

d) Revolve

e) Variable Section Sweep

f) Blend

g) Chamfer

h) Shell

i) Ribs

j) Draft

k) Pattern

Q9. What is meant by the term 'parametric' with respect to a modelling software like Creo, Solidworks, etc.? What are the various applications of Creo (Pro/E) with reference to various modules available in the software?

Q10. Write application commands in order to perform the following in AutoCAD:

a) Draw a rectangle of sides 100 X 200 using line command (incremental mode)

b) Draw array of a rectangle with 5 rows and 6 columns

Unit V

Q1. Describe least square error fitting of straight line $y = mx + c$ to various data of x and y and find the constants m and c.

Q2. From the following data, obtain Y as a linear function of X using the method of least square:

X	1.1	1.7	3.5	4.2	5.3
Y	1.3	2.1	2.5	3.6	3.6

Q3. Find the root of the equation $cos\ x = 3x - 1$ correct to three decimal places.

Q4. Find the minimum of the function $f(x) = x3 - 3x2 - 2x + 4$ within the range of (0, 4) and accuracy 0.4. Write also the method used in the form of algorithm that can be used to write a computer program.

Q5. Using Newton-Raphson method, find the solution of the following equation : $x\ sin\ x + cos\ x = 0$ (where x is near to Π).

Q6. Figure shows a spring system. Use Principle of minimum potential energy to determine displacement at the nodes.
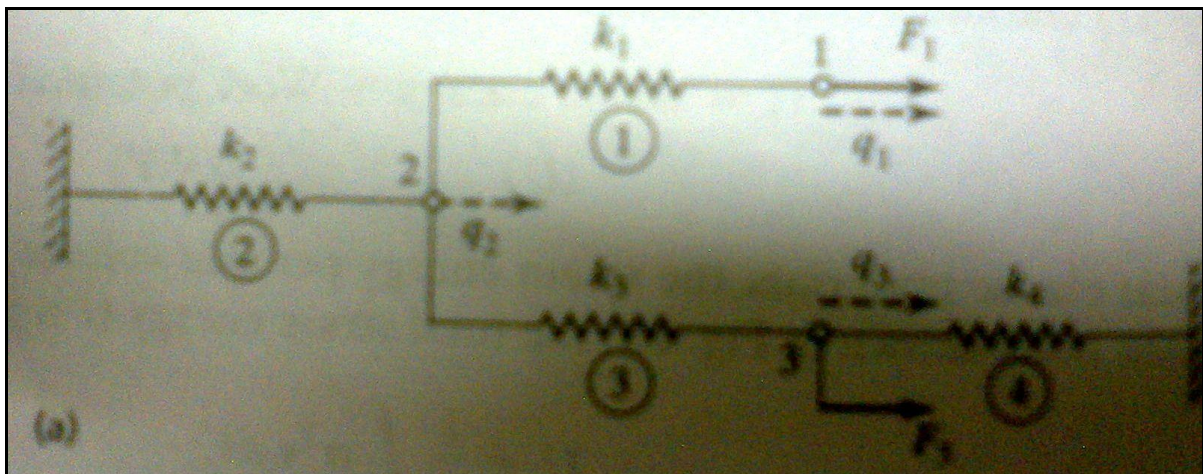
Q7. Consider the thin plate shown in fig. The plate has a uniform thickness t= 1 in., E = 30E+6 psi, and weight density $\rho = 0.2836$ lb/in^3. In addition to its self-weight, the plate is subjected to a point load P = 100 lb at its mid-point.

a) Model the plate with two finite elements.

b) Write down expressions for the element thickness matrices and element body force vectors.

c) Assemble the structural stiffness matrix **K** and global load vector **F**.

d) Using the elimination approach, solve for the global displacement vector Q.

e) Evaluate the stresses in each element.
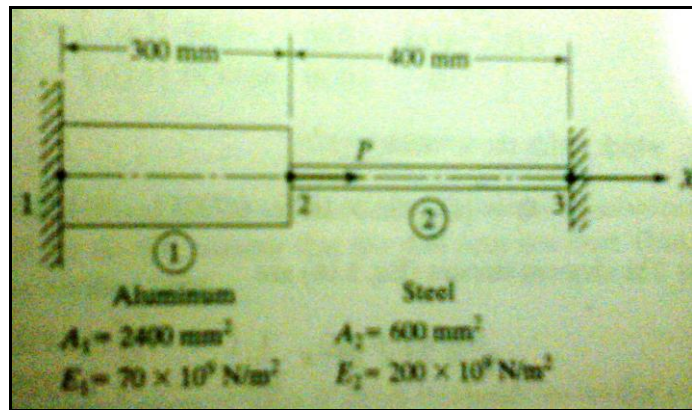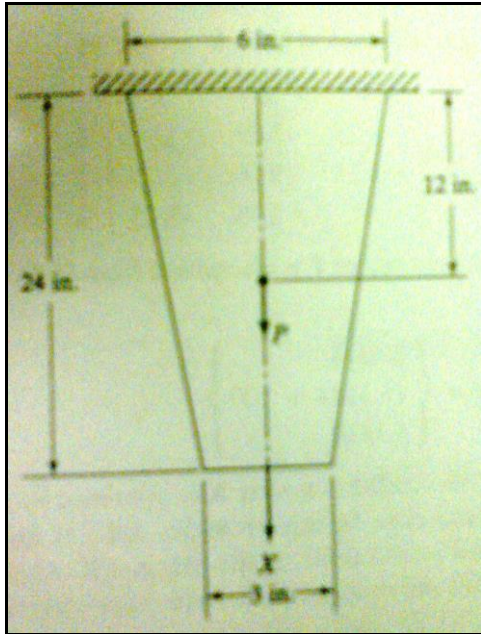
f) Determine the reaction force at the support.

Fig. for Question 7

Fig. for Question 8

Q8. Consider the bar shown in fig. An axial load $P = 200 \times 10^3$ N is applied as shown. Using the penalty approach for handling boundary conditions, do the following :

a) Determine the nodal displacements.

b) Determine the stress in each material.

c) Determine the reaction forces.

Q9. In the following fig. load $P = 60 \times 10^3$ is applied as shown. Determine the displacement field, stress and support reactions in the body. Take $E = 20 \times 10^3$ N/mm^2.
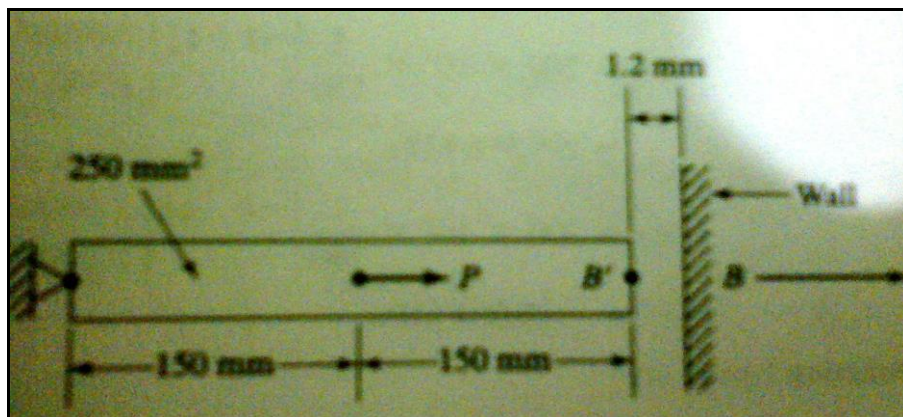
Q10. Consider the four bar truss as shown in fig. It is given that $E = 29.5 \times 10^6$ psi and $A_e = 1$ in.^{2} for all elements. Complete the following:

a) Determine the element stiffness matrix for each element.

b) Assemble the structural stiffness matrix **K** for the entire truss.

c) Using the elimination approach, solve for the nodal displacement.

d) Recover the stresses in each element.

e) Calculate the reaction forces.