## Problem 1-a Concepts

1. Vector display devices have good resolution and therefore require a large amount of memory.
2. The disadvantages of CSG modeling technique include difficulty in generating wireframe model, limitation in modeling free-form geometry, and large data storage requirement.
3. A proficient CAD user always can produce trust-worthy FEA results.
4. Geometric data in a Working Coordinate System will be finally transferred into the Model Coordinate System for storage.
5. The time-of-flight type of range sensing device provides an ideal tool for scanning mechanical parts in reverse engineering.
6. The parametric feature-based modeling system of Pro/E is based on the combination of wireframe, CSG and Brep models.
$\begin{array}{llllll}\text { F } & \text { F } & \text { F } & \text { T } & \text { F } & \text { F }\end{array}$

## Problem 1-b Concepts

- In Pro/Engineer, for a generated engineering drawing, which of the following is true?
A. One can move a right view vertically without moving the front view.
B. One can move a right view horizontally without moving the front view.
C. If the top view is fixed, no views can be moved.
D. All the views can be moved freely and independently.
- In Pro/Engineer, a datum feature (including points, curves, and surfaces) cannot be used to do which of the following?
A. Help assembling
B. Substitute simple geometric features
C. Orient a sketch plane
D. Act as a sketch plane
E. Function as a dimension reference


## Test Problem 2

A line extends from point $A$ to point $B$. A second line extends from point $C$ to point $D$.

- Define the transformation matrix for the rotation of line CD by 90 degrees about line $A B$ (counter clockwise if viewed from point $B$ to $A$ ).
- Calculate the new coordinate of point $C \& D$.
- Illustrate lines $A B, C D$ and the new locations of $C D$ in the Cartesian system.



## Part (1) of the Problem

- Step 1: Translate line $A B$ from point $A$ to the origin. The transformation matrix is

$$
\left[T^{1}\right]=\left[\begin{array}{cccc}
1 & 0 & 0 & 0 \\
0 & 1 & 0 & -1 \\
0 & 0 & 1 & -1 \\
0 & 0 & 0 & 1
\end{array}\right]
$$



- Step 2: Since line $A B$ is 45 degrees away from $Y$-axis. Rotate line $A B$ around $Z$-axis by 45 degrees and align line $A B$ with the $Y$-axis.

$$
\left[R_{z}^{2}\right]=\left[\begin{array}{cccc}
\cos 45^{\circ} & -\sin 45^{\circ} & 0 & 0 \\
\sin 45^{\circ} & \cos 45^{\circ} & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 1
\end{array}\right]=\left[\begin{array}{cccc}
0.707 & -0.707 & 0 & 0 \\
0.707 & 0.707 & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 1
\end{array}\right]
$$

- Step 3: Rotate line CD by 90 degrees around line $A B$ or Y axis. The transformation matrix is

$$
\left[R_{y}^{3}\right]=\left[\begin{array}{cccc}
\cos 90^{\circ} & 0 & \sin 90^{\circ} & 0 \\
0 & 1 & 0 & 0 \\
-\sin 90^{\circ} & 0 & \cos 90^{\circ} & 0 \\
0 & 0 & 0 & 1
\end{array}\right]=\left[\begin{array}{cccc}
0 & 0 & 1 & 0 \\
0 & 1 & 0 & 0 \\
-1 & 0 & 0 & 0 \\
0 & 0 & 0 & 1
\end{array}\right] \xrightarrow{\text { a }}
$$

- Step 4: Rotate line $A B$ around Z-axis by -45 degrees. The transformation matrix is

$$
\left[R_{z}^{4}\right]=\left[\begin{array}{cccc}
\cos \left(-45^{\circ}\right) & -\sin \left(-45^{\circ}\right) & 0 & 0 \\
\sin \left(-45^{\circ}\right) & \cos \left(-45^{\circ}\right) & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 1
\end{array}\right]=\left[\begin{array}{cccc}
0.707 & 0.707 & 0 & 0 \\
-0.707 & 0.707 & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 1
\end{array}\right]
$$

- Step 5: Translate line $A B$ back from the origin to the first location of point $A$. The transformation matrix is

$$
\left[T^{5}\right]=\left[\begin{array}{llll}
1 & 0 & 0 & 0 \\
0 & 1 & 0 & 1 \\
0 & 0 & 1 & 1 \\
0 & 0 & 0 & 1
\end{array}\right]
$$



- Step 6: The equivalent matrix of the process is

$$
\begin{aligned}
& {[E]=\left[T^{5}\right]\left[R_{z}^{4}\right]\left[R_{y}^{3}\right]\left[R_{z}^{2}\right]\left[T^{1}\right]} \\
& =\left[\begin{array}{cccc}
1 & 0 & 0 & 0 \\
0 & 1 & 0 & 1 \\
0 & 0 & 1 & 1 \\
0 & 0 & 0 & 1
\end{array}\right]\left[\begin{array}{cccc}
0.707 & 0.707 & 0 & 0 \\
-0.707 & 0.707 & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 1
\end{array}\right]\left[\begin{array}{cccc}
0 & 0 & 1 & 0 \\
0 & 1 & 0 & 0 \\
-1 & 0 & 0 & 0 \\
0 & 0 & 0 & 1
\end{array}\right]\left[\begin{array}{ccc}
0.707 & -0.707 & 0 \\
0.707 & 0.707 & 0 \\
0 \\
0 & 0 & 1 \\
0 \\
0 & 0 & 0
\end{array}\right]\left[\begin{array}{cccc}
1 & 0 & 0 & 0 \\
0 & 1 & 0 & -1 \\
0 & 0 & 1 & -1 \\
0 & 0 & 0 & 1
\end{array}\right] \\
& =\left[\begin{array}{cccc}
0.5 & 0.5 & 0.707 & -1.207 \\
0.5 & 0.5 & -0.707 & 1.207 \\
-0.707 & 0.707 & 0 & 0.293 \\
0 & 0 & 0 & 1
\end{array}\right]
\end{aligned}
$$

## Part (2) of the Problem

- The points $C$ and $D$ will be relocated as

$$
\begin{aligned}
& C^{\prime}=[E] C=\left[\begin{array}{cccc}
0.5 & 0.5 & 0.707 & -1.207 \\
0.5 & 0.5 & -0.707 & 1.207 \\
-0.707 & 0.707 & 0 & 0.293 \\
0 & 0 & 0 & 1
\end{array}\right]\left[\begin{array}{l}
0 \\
0 \\
0 \\
1
\end{array}\right]=\left[\begin{array}{c}
-1.207 \\
1.207 \\
0.293 \\
1
\end{array}\right] \\
& D^{\prime}=[E] D=\left[\begin{array}{cccc}
0.5 & 0.5 & 0.707 & -1.207 \\
0.5 & 0.5 & -0.707 & 1.207 \\
-0.707 & 0.707 & 0 & 0.293 \\
0 & 0 & 0 & 1
\end{array}\right]\left[\begin{array}{l}
0 \\
2 \\
0 \\
1
\end{array}\right]=\left[\begin{array}{c}
-0.207 \\
2.207 \\
1.707 \\
1
\end{array}\right]
\end{aligned}
$$

- Thus the new coordinates of point $C$ and $D$ are (-1.207, $1.207,0.293$ ) and (-0.207, 2.207, 1.707), respectively.


## Part (3) of the Problem



