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Class: Btech III, Computer Eng.

Sem: Semester 6

Computer Graphics
Tutorial 4

Ans 1;

$$X = \begin{bmatrix} 1 & 1 & 1 \\ 2 & 1 & 1 \\ 2 & 2 & 1 \\ 1 & 2 & 1 \end{bmatrix}$$

$$T_1 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ -2 & -1 & 1 \end{bmatrix} \qquad R = \begin{bmatrix} 0.707 & -0.707 & 0 \\ -0.707 & 0.707 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$T_2 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 2 & 1 & 1 \end{bmatrix}$$

$$T_1 R T_2 = \begin{bmatrix} 0.707 & 0.707 & 0 \\ -0.707 & 0.707 & 0 \\ 1.293 & -1.707 \end{bmatrix}$$

$$X' = X(T_1 R T_2) = \begin{bmatrix} 1.293 & 0.293 & 1 \\ 2 & 1 & 1 \\ 1.293 & 1.707 & 1 \\ 0.586 & 1 & 1 \end{bmatrix}$$

Ans 2, $X = \begin{bmatrix} 0 & 0 & 1 \\ 5 & 0 & 1 \\ 5 & 5 & 1 \\ 0 & 5 & 1 \end{bmatrix}$

$T = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 2 & 2 & 1 \end{bmatrix}$

$S = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 1.5 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

$TS = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 1.5 & 0 \\ 4 & 3 & 1 \end{bmatrix}$

$X' = X(TS) = \begin{bmatrix} 4 & 3 & 1 \\ 14 & 3 & 1 \\ 14 & 10.5 & 1 \\ 4 & 10.5 & 1 \end{bmatrix}$

Ans 3, $X = \begin{bmatrix} 2 & 1 & 1 \\ 4 & 3 & 1 \\ 2 & 3 & 1 \end{bmatrix}$

$XSH = \begin{bmatrix} 1 & 0 & 0 \\ 2 & 4 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ $\qquad$ $YSH = \begin{bmatrix} 1 & 2 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

$XSH \times YSH = \begin{bmatrix} 1 & 2 & 0 \\ 2 & 5 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ $\qquad$ $X' = X(XSH \times YSH) = \begin{bmatrix} 4 & 9 & 1 \\ 10 & 23 & 1 \\ 8 & 19 & 1 \end{bmatrix}$

Ans 4: $R = \begin{bmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

$T = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 10 & 0 & 1 \end{bmatrix}$

$S = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

$RTS = \begin{bmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 10 & 0 & 1 \end{bmatrix} \begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

$= \begin{bmatrix} 0 & 2 & 0 \\ -2 & 0 & 0 \\ 20 & 0 & 1 \end{bmatrix}$

Ans 5: $X = \begin{bmatrix} 5 & 1 & 1 \\ 6 & 3 & 1 \\ 7 & 1 & 1 \end{bmatrix}$

$T_1 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & -3 & 1 \end{bmatrix}$

$P = \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ $\& T_2 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 3 & 1 \end{bmatrix}$

$$T_1 P T_2 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 6 & 1 \end{bmatrix}$$

$$X' = X(T_1 P T_2)$$
$$= \begin{bmatrix} 5 & 5 & 1 \\ 6 & 3 & 1 \\ 7 & 5 & 1 \end{bmatrix}$$

Ans b₂ $X = \begin{bmatrix} 3 & 4 & 1 \end{bmatrix}$

Line: $y = -2x + 6$
y intercept = 6
Slope = -2
$\theta = 63°$ clockwise
$\sin \theta = 0.8944$
$\cos \theta = 0.4472$

$$T_1 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & -6 & 1 \end{bmatrix} \quad R_1 = \begin{bmatrix} 0.4472 & 0.8944 & 0 \\ -0.8944 & 0.4472 & 0 \\ 0 & 0 & 1 \end{bmatrix} \quad P = \begin{bmatrix} +1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$R_2 = \begin{bmatrix} 0.4472 & -0.8944 & 1 \\ 0.8944 & 0.4472 & 1 \\ 0 & 0 & 1 \end{bmatrix} \quad T_2 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 6 & 1 \end{bmatrix}$$

$$X' = X(T_1 R_1 P R_2 T_2) = \begin{bmatrix} 0.2 & 1.95 & 0.5 & 84 \end{bmatrix} \quad \overset{2.4}{\begin{bmatrix} 0.2 & 9.6 & 1 \end{bmatrix}}$$

Ans 7:

$$X = \begin{bmatrix} 2 & 2 & 1 \\ 4 & 2 & 1 \\ 4 & 4 & 1 \end{bmatrix}$$

$$R_1 = \begin{bmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$R_2 = \begin{bmatrix} 0.707 & 0.707 & 0 \\ -0.707 & 0.707 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$P = \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$R_3 = \begin{bmatrix} 0.707 & -0.707 & 0 \\ 0.707 & 0.707 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$X' = X R_1 R_2 P R_3 = \begin{bmatrix} -2 & 2 & 1 \\ -4 & 2 & 1 \\ -4 & 4 & 1 \end{bmatrix}$$

Ans 8: $X = \begin{bmatrix} 2 & 3 & 1 \\ 6 & 3 & 1 \\ 4 & 8 & 1 \end{bmatrix}$

$Y = 3x + 4$

$T_1 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & -4 & 1 \end{bmatrix}$

$\theta = 7 \tan^{-1} 3 = 71.562°$

$\sin \theta = 0.9482$

$\cos \theta = 0.3162$

$R_1 = \begin{bmatrix} 0.3162 & -0.9484 & 0 \\ +0.9484 & 0.3162 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

$P = \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ $R_2' = \begin{bmatrix} 0.3162 & 0.9484 & 0 \\ -0.9484 & 0.3162 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ $T_2 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 4 & 1 \end{bmatrix}$

$X' = X(T_1 R_1 P R_2' T_2') = \begin{bmatrix} -2.2 & 144 & 1 \\ -5.4 & 6.8 & 1 \\ -0.8 & 9.6 & 1 \end{bmatrix}$

Ans 9: $X = \begin{bmatrix} 3 & 2 & 1 & 1 \end{bmatrix}$

$$T_1 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -1 & -1 & -1 & 1 \end{bmatrix}$$

$$R_1 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0.866 & 0.5 & 0 \\ 0 & -0.5 & 0.866 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$R_2 = \begin{bmatrix} 0.707 & 0 & 0.707 & 0 \\ 0 & 1 & 0 & 0 \\ -0.707 & 0 & 0.707 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$X' = X(T_1 R_1 R_2) = \begin{bmatrix} 0.9898 & 0.866 & 1.8382 & 1 \end{bmatrix}$$

Ans 10: $X = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 2 & 1 & 2 & 1 \\ 2 & 2 & 2 & 1 \\ 1 & 2 & 2 & 1 \\ 1 & 1 & 2 & 1 \\ 2 & 1 & 1 & 1 \\ 2 & 2 & 1 & 1 \\ 1 & 2 & 1 & 1 \end{bmatrix}$ Centroid $= \begin{bmatrix} 1.5 & 1.5 & 1.5 \end{bmatrix}$

$$T_1 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -15 & -15 & -15 & 1 \end{bmatrix}$$

$$R_1 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0.866 & 0.50 & 0 \\ 0 & -0.5 & 0.866 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_2 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 1.5 & 15+0.5 & & 1 \end{bmatrix}$$

$$X' = X(T_1 R_1 T_2) = \begin{bmatrix} 0.1294 & -0.1830 & 0.84 & 1 \\ 0.224 & -0.683 & 0.48 & \\ 1 & 1.317 & 0.817 & 1 \\ 2 & 0.817 & 1.68 & 1 \\ 2 & 1.68 & 2.18 & 1 \\ 1 & 1.68 & 2.18 & 1 \\ 1 & 0.817 & 1.68 & 1 \\ 2 & 2.13 & 0.817 & 1 \\ 2 & 2.18 & 1.31 & 1 \\ 1 & 2.18 & 1.31 & 1 \end{bmatrix}$$

Ans 11. $X = \begin{bmatrix} 0 & 0 & 0 & 1 \\ 1 & 1 & 2 & 1 \\ 1 & 1 & 3 & 1 \end{bmatrix}$

$X_{sh} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 2 & 1 & 0 & 0 \\ 2 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$
$\qquad Y_{sh} = \begin{bmatrix} 1 & 2 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 2 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

$Z_{sh} = \begin{bmatrix} 1 & 0 & 3 & 0 \\ 0 & 1 & 3 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

$X' = X(X_{sh} \, Y_{sh} \, Z_{sh}) = \begin{bmatrix} 0 & 0 & 0 & 1 \\ 7 & 19 & 80 & 1 \\ 9 & 25 & 105 & 1 \end{bmatrix}$