1. $x = (5,6)^T \quad y = (-3,7)^T$

$\rightarrow$ in Homogeneous Coordinates: $x = (5,6,1)^T \quad y = (-3,7,1)^T$

a> connecting line $I = x \times y = \begin{pmatrix} 5 \\ 6 \\ 1 \end{pmatrix} \times \begin{pmatrix} -3 \\ 7 \\ 1 \end{pmatrix} = \begin{pmatrix} 6-7 \\ -3-5 \\ -18-35 \end{pmatrix} = \begin{pmatrix} -1 \\ -8 \\ -53 \end{pmatrix}$

$\begin{matrix} 5 & -3 \\ 6 & 7 \\ 1 & 1 \end{matrix}$

b> $t = (6,-7)^T \quad dx = 6 \quad dy = -7 \quad \varphi = 135^\circ \quad \lambda = 6$

$H = \begin{bmatrix} \lambda R & t \\ 0^T & 1 \end{bmatrix} = \begin{bmatrix} 6\cos\varphi & -6\sin\varphi & dx \\ 6\sin\varphi & 6\cos\varphi & dy \\ 0 & 0 & 1 \end{bmatrix} = \cancel{\begin{bmatrix} -3\sqrt{2} & 3\sqrt{2} & 6 \\ 3\sqrt{2} & -3\sqrt{2} & 7 \\ 0 & 0 & 1 \end{bmatrix}} = S \times R \times T = \begin{bmatrix} -4.24 & -4.24 & 4.24 \\ 4.24 & -4.24 & 55.15 \\ 0 & 0 & 1 \end{bmatrix}$

$X' = Hx = \cancel{(3\sqrt{2}+6, \; -3\sqrt{2}-7, \; 1)}^T = (-42.43, 50.91, 1)^T$

$y' = Hy = \cancel{\left(\frac{11\sqrt{2}}{2}+6, \; -\frac{45}{2}\sqrt{2}-7, \; 1\right)}^T = (-12.73, 12.73, 1)^T$

c>

$I' = (H^{-1})^T I = (1.06, 0.83, 3)^T$

2. $x' \times y' = \begin{pmatrix} -42.43 \\ 50.91 \\ 1 \end{pmatrix} \times \begin{pmatrix} -12.73 \\ 12.73 \\ 1 \end{pmatrix} = \begin{pmatrix} 50.91 - 12.73 \\ +42.43 - 12.73 \\ -12.73(42.43 - 50.91) \end{pmatrix} = 36 \begin{pmatrix} 1.06 \\ 0.83 \\ 3 \end{pmatrix} = I'$

$\begin{matrix} -42.43 & -12.73 \\ 50.91 & 12.73 \\ 1 & 1 \end{matrix}$

still on the line.

3. $l = (6,-2,2)^T = -2(-3,1,-1)^T = -2\begin{pmatrix} \frac{1}{x_0} \\ \frac{1}{y_0} \\ -1 \end{pmatrix} \quad x_0 = -\frac{1}{3} \quad y_0 = 1$

the axis-intercept form $\frac{x}{x_0} + \frac{y}{y_0} - 1 = 0 \rightarrow -3x + y - 1 = 0$

the Hessian normal form $x\cos\varphi + y\sin\varphi - d = 0$.

$(a,b,c)^T = (6,-2,2)^T \quad a = 6 \quad b = -2 \quad c = 2$

$\phi = a\tan\left(\frac{b}{a}\right) = -18.43^\circ \quad \cos\varphi = 0.95 \quad \sin\varphi = -0.32 \quad -d = 0.32$

$0.95x - 0.32y - 0.32 = 0$