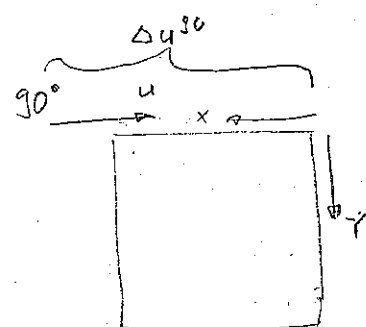
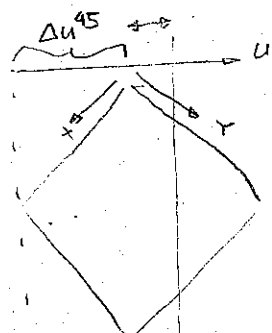
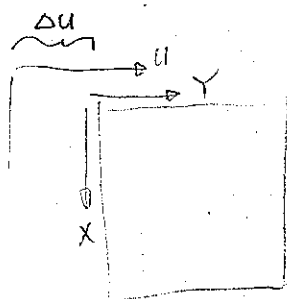


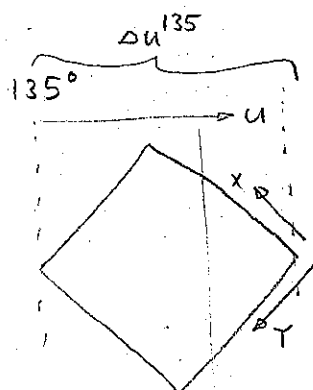
For uns

$$0^\circ -Y + u - \Delta u^0 = 0$$

$$45^\circ (-Y + X + (u - \Delta u^{45}) \cdot \sqrt{2}) = 0$$

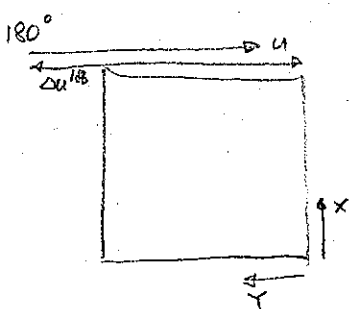


$$(-X + \Delta u^{90} - u) = 0$$

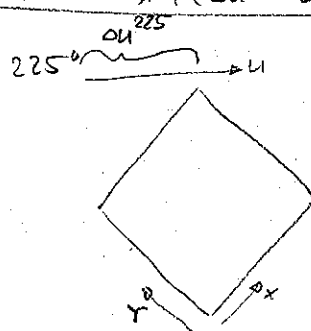


$$+Y = -X + (\Delta u^{135} - u) \cdot \sqrt{2}$$

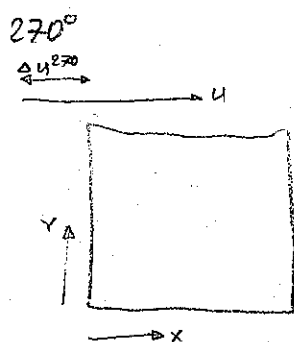
$$-X + (\Delta u^{135} - u) \sqrt{2} - Y = 0$$



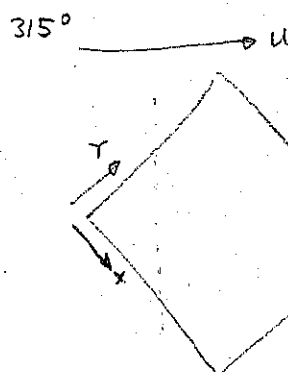
$$-Y + \Delta u^{180} - u = 0$$



$$-Y + X + (\Delta u^{225} - u) \sqrt{2} = 0$$



$$-X + u - \Delta u^{270} = 0$$



$$-Y - X + u \sqrt{2} = 0$$

In Matrix form:

$$\underbrace{\begin{pmatrix} 0 & 0 & -1 \\ 5 & 1 & -1 \\ 0 & -1 & 0 \\ 35 & -1 & -1 \\ 30 & 0 & -1 \\ 25 & 1 & -1 \\ 70 & -1 & 0 \\ 15 & -1 & -1 \end{pmatrix}}_A \underbrace{\begin{pmatrix} x \\ y \end{pmatrix}}_x + \underbrace{\begin{pmatrix} u - \Delta u^0 \\ (u - \Delta u^{45}) \cdot \sqrt{2} \\ \Delta u^{90} - u \\ (\Delta u^{135} - u) \cdot \sqrt{2} \\ \Delta u^{180} - u \\ (\Delta u^{225} - u) \cdot \sqrt{2} \\ u - \Delta u^{270} \\ u \cdot \sqrt{2} \end{pmatrix}}_b = r$$

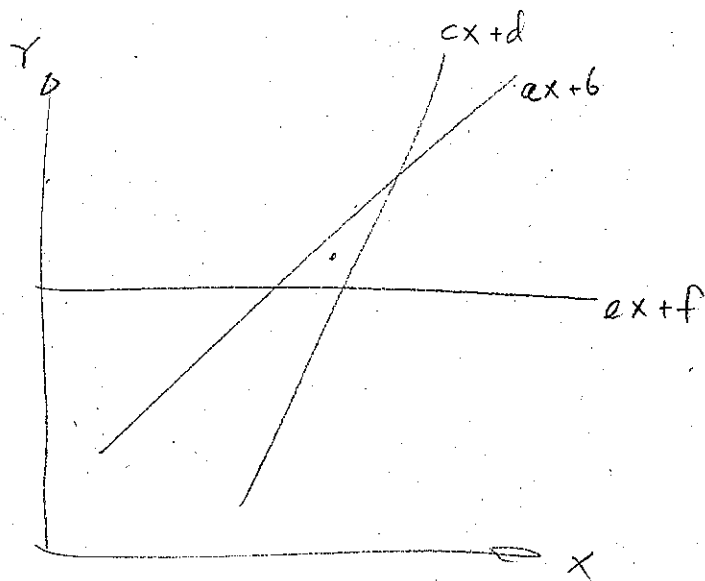
kann beliebig gross sein

Normalen Gleichung

$$A^T A x = A^T b$$

$\Rightarrow$  solve for  $x$

# Normalgleichung



Gegeben:  $a, \dots, f$

Gesucht:  $x, y$

$$ax + b - y = r_1$$

$$cx + d - y = r_2$$

$$ex + f - y = r_3$$

$$\underbrace{\begin{pmatrix} a & -1 \\ c & -1 \\ e & -1 \end{pmatrix}}_A \underbrace{\begin{pmatrix} x \\ y \end{pmatrix}}_x + \underbrace{\begin{pmatrix} b \\ d \\ f \end{pmatrix}}_b = r$$

Normalgleichung  $A^T A x = A^T b$

$$A^T A = \begin{pmatrix} a & c & e \\ -1 & -1 & -1 \end{pmatrix} \begin{pmatrix} a & -1 \\ c & -1 \\ e & -1 \end{pmatrix} = \begin{pmatrix} a^2 + c^2 + e^2 & (-a - c - e) \\ (-a - c - e) & 3 \end{pmatrix} \quad A^T b = \begin{pmatrix} a & c & e \\ -1 & -1 & -1 \end{pmatrix} \begin{pmatrix} b \\ d \\ f \end{pmatrix} = \begin{pmatrix} ab + cd + ef \\ -b - d - f \end{pmatrix}$$

Zu lösende Gleichung

$$\begin{pmatrix} a^2 + c^2 + e^2 & -a - c - e \\ -a - c - e & 3 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} ab + cd + ef \\ -b - d - f \end{pmatrix}$$