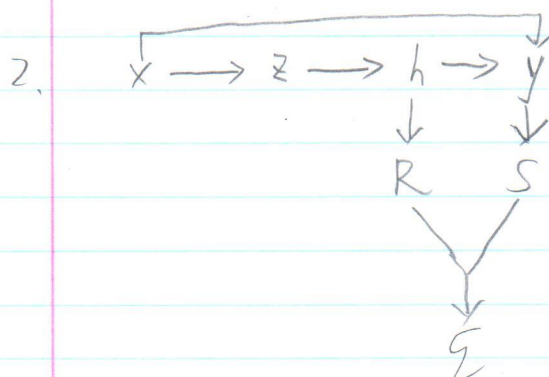1. $W = \begin{bmatrix} 1 & -1 & 0 & 0 \\ 0 & 1 & -1 & 0 \\ 0 & 0 & 1 & -1 \end{bmatrix}$

$b = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$

$w = \begin{bmatrix} -1 \\ -1 \\ -1 \end{bmatrix}$

$b = 0$

2.

$x \longrightarrow z \longrightarrow h \longrightarrow y$
$\quad\quad\quad\quad\quad \downarrow \quad\quad \downarrow$
$\quad\quad\quad\quad\quad R \quad\quad S$
$\quad\quad\quad\quad\quad\quad \searrow \swarrow$
$\quad\quad\quad\quad\quad\quad\quad \downarrow$
$\quad\quad\quad\quad\quad\quad\quad \mathcal{E}$

$\bar{\mathcal{E}} = 1$

$\bar{R} = \bar{\mathcal{E}} \cdot 1 \quad\quad \bar{S} = \bar{\mathcal{E}} \cdot 1$

$\bar{y} = \bar{S} \cdot (y - s)$

$\bar{h} = (w^{(2)})^T \bar{y} + r\bar{R}$

$\bar{z} = \sigma'(z) \, \bar{h}$

$\bar{x} = (w^{(1)})^T \bar{z} + 1_{N \times N} (y - s)$

$\bar{x} = (w^{(1)})^T (\sigma'(z))^T \left( (w^{(2)})^T (y-s) + r \right) + 1_{N \times N} (y-s)$

3. $y = w_1 h_1 + w_5 h_2$
$h_1 = ReLU(w_2 h_3 + h_4)$
$h_2 = ReLU(w_4 h_3 + h_4)$
$h_3 = ReLU(w_3 x_1 + x_2)$
$h_4 = ReLU(x_1 + x_2)$

$\boxed{h_1 = 0 \quad h_1' = 0}$

$\dfrac{\partial L}{\partial w_1} = (w_1 h_1 + w_5 h_2 - t) \cdot h_1 \quad \boxed{Yes}$

$\quad\quad = 0$

$ReLU'(z) = \begin{cases} 1 & \text{if } z \geq 0 \\ 0 & \text{if } z < 0 \end{cases}$

$ReLU(z) = \begin{cases} z & \text{if } z \geq 0 \\ 0 & \text{if } z < 0 \end{cases}$

$\dfrac{\partial L}{\partial w_2} = (w_1 ReLU(w_2 h_3 + h_4) + w_5 h_2) \cdot w_1 ReLU'(w_2 h_3 + h_4) \cdot h_3$

$\quad\quad = 0. \quad\quad \boxed{Yes}$

$$\frac{\partial L}{\partial W_3} = (W_1 h_1 + W_5 h_2)(W_1 h_1' + W_5 h_2')(W_2 h_3' + W_4 h_3') 2X_1$$

$$= W_5 h_2 \cdot W_5 h_2' (W_2 h_3' + W_4 h_3') 2X_1 \qquad \boxed{No}$$