1. The pseudo-inverse of $\mathbf{X}$ is $(\mathbf{X}^T\mathbf{X})^{-1}\mathbf{X}^T = \frac{1}{4}\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -1 & -1 & 1 \end{bmatrix}$

   Ans c
2. Since $\bar{\mathbf{x}} \succcurlyeq \mathbf{0}$, it follows that $\bar{\mathbf{c}}^T\bar{\mathbf{x}} \geq \min\{\mathbf{c}_i\}\sum_{i=1}^{n} x_i = \min\{\mathbf{c}_i\}$. This can be achieved by setting x_i corresponding to index i for which c_i is minimum to 1 and rest to 0

   Ans d
3. The constraint for the beamformer $\bar{\mathbf{w}}$, with estimate of the nominal CSI denoted by $\bar{\mathbf{h}}_e$, for a suitable matrix $\mathbf{P}$, is $\|\mathbf{P}^T\bar{\mathbf{w}}\| \leq \bar{\mathbf{w}}^T\,\bar{\mathbf{h}}_e - 1$

   Ans d
4. Given the base station cooperation problem with K base stations, M users, $P_{i,j}, h_{i,j}$ denoting the power and channel coefficient from base station i to user j, respectively. As shown in lectures, the minmax optimization problem is

$$\min.\, t$$
$$\text{s.t.} \sum_j P_{i,j} \leq t, 1 \leq i \leq K$$
$$\sum_i P_{i,j}\left|h_{i,j}\right|^2 \geq \tilde{P}_j, 1 \leq j \leq M$$

   Ans c
5. The channel estimate is

$$(\mathbf{X}^T\mathbf{X})^{-1}\mathbf{X}^T\mathbf{y}$$
$$= \left(\begin{bmatrix} -1 & 1 & 1 & -1 \\ 1 & -1 & 1 & -1 \end{bmatrix}\begin{bmatrix} -1 & 1 \\ 1 & -1 \\ 1 & 1 \\ -1 & -1 \end{bmatrix}\right)^{-1}\begin{bmatrix} -1 & 1 & 1 & -1 \\ 1 & -1 & 1 & -1 \end{bmatrix}\begin{bmatrix} 2 \\ 3 \\ 1 \\ -2 \end{bmatrix}$$
$$= \begin{bmatrix} 2 \\ 0 \end{bmatrix}$$

   Ans c
6. The pseudo-inverse of $\mathbf{X}$ is $(\mathbf{X}^T\mathbf{X})^{-1}\mathbf{X}^T = \frac{1}{4}\begin{bmatrix} -1 & 1 & 1 & -1 \\ 1 & -1 & 1 & -1 \end{bmatrix}$

   Ans a
7. The optimal vector $\bar{\mathbf{x}}$ that minimizes the regularized least-squares cost function $\min.\left\|\mathbf{A}\bar{\mathbf{x}} - \bar{\mathbf{b}}\right\|^2 + \lambda\|\bar{\mathbf{x}}\|^2$ is $(\mathbf{A}^T\mathbf{A} + \lambda\mathbf{I})^{-1}\mathbf{A}^T\bar{\mathbf{b}}$

   Ans b
8. Given the full column rank matrix $\mathbf{A}$. The projection matrix for the column space of $\mathbf{A}$ is $\mathbf{A}(\mathbf{A}^T\mathbf{A})^{-1}\mathbf{A}^T$

   Ans d
9. Given the least-squares problem $\min.\|\bar{\mathbf{y}} - \mathbf{A}\bar{\mathbf{x}}\|^2$, with $\bar{\mathbf{y}} - \mathbf{A}\bar{\mathbf{x}} = \bar{\mathbf{e}}$.. For the optimal solution $\hat{\mathbf{x}}$, the corresponding error vector $\bar{\mathbf{a}}$ is perpendicular to each column of $\mathbf{A}$

   Ans c
10. The channel estimate is

$$(\mathbf{X}^T\mathbf{X})^{-1}\mathbf{X}^T\mathbf{y} = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$$

   Ans a