Name: ______________________ Roll Number: ______________________

1. (5 points) Show that the 3×9 system matrix $\mathbf{A}_i$ below has only 2 linearly independent rows.

$$\begin{bmatrix} \mathbf{0}^T & -w_i'\mathbf{x}_i^T & y_i'\mathbf{x}_i^T \\ w_i'\mathbf{x}_i^T & \mathbf{0}^T & -x_i'\mathbf{x}_i^T \\ -y_i'\mathbf{x}_i^T & x_i'\mathbf{x}_i^T & \mathbf{0}^T \end{bmatrix}_{3\times 9} \begin{bmatrix} \mathbf{h}^1 \\ \mathbf{h}^2 \\ \mathbf{h}^3 \end{bmatrix}_{9\times 1} = \mathbf{A}_i\mathbf{h} = \mathbf{0}$$

2. (1 point) Which of the following can be the last row of an affine transformation matrix in $\mathbb{P}^2$?
   A. $\begin{bmatrix} 1 & 0 & 0 \end{bmatrix}$
   B. $\begin{bmatrix} 0 & 0 & 3 \end{bmatrix}$
   C. $\begin{bmatrix} 0 & 0 & 0 \end{bmatrix}$
   D. $\begin{bmatrix} 0 & 1 & 0 \end{bmatrix}$

3. (4 points) Write down the sequence of matrix multiplications (in the correct order) that will
   1. first scale the 2D point (x, y) by 3 in the x-direction and 5 in the y-direction,
   2. then rotate the result by 45° counter-clockwise,
   3. then translate the result by -3 in the x-direction and 7 in the y-direction,
   4. and finally rotate by 30° clockwise.

   You are only allowed to use matrix-vector multiplications.