

**ECE 472 Robotics and Vision**  
**Prof. K. Dana**  
*Homework 1: Linear Algebra Review*

*Directions: Hand in one pdf (from your written work) and one .py file (from the last question). Use the naming convention described on the first day of class.*

1. Are the following vectors basis vectors for  $\mathbb{R}^3$ ? Why or why not?

$$w_1 = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}, w_2 = \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}, w_3 = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \quad (1)$$

2. Do you think the following can also be basis vectors for  $\mathbb{R}^3$ ? Why or why not?

$$t_1 = \begin{bmatrix} 0.707 \\ -0.707 \\ 0 \end{bmatrix}, t_2 = \begin{bmatrix} -0.707 \\ 0.707 \\ 0 \end{bmatrix}, t_3 = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \quad (2)$$

3. Do the following vectors span  $\mathbb{R}^3$ ? Why or why not?

$$w_1 = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}, w_2 = \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}, w_3 = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}, w_4 = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} \quad (3)$$

4. Given the following coordinates for measurement points, solve problem of fitting a line to these points using linear least square estimation. You are to solve the problem **two** ways: (1) by hand, (2) with python or matlab (to check solution). Be sure to set up the problem in the form  $Aq = b$  by defining  $A$  and  $b$ . Then compute the parameter vector  $q$  using least squares estimation.  $x_1 = 0, y_1 = 1$

$$x_2 = 1, y_2 = 3.2$$

$$x_3 = 1.9, y_3 = 5$$

$$x_4 = 3, y_4 = 7.2$$

$$x_5 = 3.9, y_5 = 9.3$$

$$x_6 = 5, y_6 = 11.1$$

5. Describe how to test the conjecture that there are only 2 independent columns in the matrix below. Write a python program to test the conjecture that there are only 2

independent columns in the matrix below.  $A = \begin{bmatrix} 4.29 & 2.2 & 5.51 \\ 5.20 & 10.1 & -8.24 \\ 1.33 & 4.8 & -6.62 \end{bmatrix}$