Instructions

1. Separate into groups of no more than three persons.
2. Only one submission is needed for each group. Late submission will not be accepted.
3. ***Write down all the steps*** that you have done to obtain your answers. You may not get full credit even when your answer is correct without showing how you get your answer.
4. **Do not panic.**

Name	ID

A 64×64 Hadamard matrix is created in `MATLAB` via the command

$$H = \text{hadamard}(64).$$

Note that the elements of `H` are all 1 or -1. Of course, there are 4,096 elements in `H`. Writing them all down would take too much time. So, in this question, you are asked to identify only parts a and b that are shown in the following picture:

$$H_2 = \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$$

$$H_4 = H_2 \otimes H_2 = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -1 & 1 & -1 \\ 1 & 1 & -1 & -1 \\ 1 & -1 & -1 & 1 \end{bmatrix}$$

$$H_{64} = H_{16} \otimes H_4$$

$$H_{16} = H_4 \otimes H_4$$

$$H_{16}(1,1) = H_4(1,1) \times H_4(1,1) = 1$$

$$H_{16}(16,16) = H_4(16,16) \times H_4(16,16) = 1$$

Column#

Row#
a — rows 1 to 4, columns 1 to 4
b — rows 61 to 64, columns 61 to 64

Remark: The picture is not drawn to scale.

a. (4 pt) Find `H(1:4,1:4)`. (This is the part of H that is denoted by (a) in the picture above. It covers rows 1 to 4 and columns 1 to 4.)

$$\begin{bmatrix} a \end{bmatrix} = \underbrace{H_{16}(1,1)}_{1} \times H_4 = H_4 = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -1 & 1 & -1 \\ 1 & 1 & -1 & -1 \\ 1 & -1 & -1 & 1 \end{bmatrix}$$

b. (2 pt) Find `H(61:64,61:64)`.

$$\begin{bmatrix} b \end{bmatrix} = \underbrace{H_{16}(16,16)}_{1} \times H_4 = H_4 = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -1 & 1 & -1 \\ 1 & 1 & -1 & -1 \\ 1 & -1 & -1 & 1 \end{bmatrix}$$