1. Compute by hand the $LU$ factorization with row partial pivoting of the matrix

$$A = \begin{bmatrix} -1 & 4 & 0 & -1 \\ -1 & 0 & 4 & -1 \\ 4 & -1 & -1 & 0 \\ 0 & -1 & -1 & 4 \end{bmatrix}.$$ 

Use the form of calculation in which the $4 \times 4$ data structure originally containing $A$ is gradually overwritten by the $L$ and $U$ factors, keeping track of the permutation sequence. Write out clearly the $L$, $U$, and $P$ matrices that you obtain from this process.

2. Write a Matlab code `lupp.m` to form the $LU$ factorization of an $n \times n$ matrix $A$ with partial pivoting. Your code should overwrite the data structure of the input matrix with the $L$ and $U$ factors. It should also return the permutation matrix $P$, stored in coded form as a string of $n$ integer values. (See stub on the web site.)

3. Write a Matlab code `lutri.m` to take the $L$ and $U$ factors from `lupp.m`, and the permutation matrix $P$, and return a solution to $Ax = b$ for a given $b$. (See stub on the web site.)

4. Use your codes to solve $Ax = b$ for the following matrix $A$ and the two right-hand sides $b$. Print out the solution $x$ and the permutation vector $P$ in each case.

$$A = \begin{bmatrix} 2 & -1 & 4 & 9 & 2 \\ 1 & 0 & 3 & 9 & 7 \\ -5 & 0 & 1 & 3 & 5 \\ 4 & 3 & 2 & 2 & 7 \\ 3 & 0 & 0 & 0 & 9 \end{bmatrix}, \quad b = \begin{bmatrix} 2 \\ -1 \\ 3 \\ 8 \\ 4 \end{bmatrix}, \quad b = \begin{bmatrix} 4 \\ 0 \\ 5 \\ -2 \\ 1 \end{bmatrix}.$$ 

Hand in hard copies of your codes `as7.m`, `lupp.m`, `lutri.m`, and your output together with your written answers. Put your codes in a directory called `homework7`. From the parent directory of `homework7`, run the following command:

```
handin -c cs416-1 -a hwk7 -d homework7
```