# BIOE 210, Spring 2022

Homework 2

Due Monday, 1/31/2022 by 5:00pm.
**You must upload your answers to Compass and assign each question.**

1. Are the following products conformable? If so, what are the dimensions of the final products?

$$\mathbf{Q} = \begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}, \quad \mathbf{P} = \begin{pmatrix} 5 & 6 \\ 7 & 8 \\ 0 & 9 \end{pmatrix}, \quad \mathbf{x} = \begin{pmatrix} 8 \\ 7 \end{pmatrix}$$

   (a) $\mathbf{QP}$
   (b) $\mathbf{PQ}$
   (c) $\mathbf{QP}^\mathsf{T}$
   (d) $\mathbf{Q}^\mathsf{T}\mathbf{P}^\mathsf{T}$
   (e) $\mathbf{Qx}$
   (f) $\mathbf{Px}$
   (g) $\mathbf{x}^\mathsf{T}\mathbf{Q}$
   (h) $\mathbf{x}^\mathsf{T}\mathbf{Qx}$

2. Compute the following products.

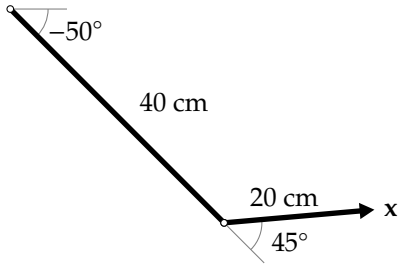
   (a)
$$\begin{pmatrix} 1 & 0 & 2 \\ 0 & -1 & 4 \end{pmatrix} \begin{pmatrix} -1 & 1 \\ 2 & 0 \\ 3 & 5 \end{pmatrix}$$

   (b)
$$\begin{pmatrix} 3 & a \\ b & -4 \end{pmatrix} \begin{pmatrix} a \\ 2 \end{pmatrix}$$

   (c)
$$\begin{pmatrix} 1 & 3 \\ 2 & -1 \end{pmatrix} \begin{pmatrix} 1 & 3 \\ 2 & -1 \end{pmatrix}^\mathsf{T} \begin{pmatrix} 1 & 3 \\ 2 & -1 \end{pmatrix}$$

   (d)
$$\begin{pmatrix} x_1 & x_2 \end{pmatrix} \begin{pmatrix} 1 & -1 \\ -1 & 2 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix}$$

3. Using rotation and translation matrices, find the position ($\mathbf{x}$) of the end of the following multi-bar linkage arm.




4. Imagine a square with vertices $(1, 0)$, $(2, 0)$, $(2, 1)$, and $(1, 1)$. Using rotation and translation matrices, (a) shift the square left by 1 (so the bottom left vertex is at the origin), rotate it 40° counter-clockwise, and shift the square back to the right by 1. What are the final locations of the vertices? You can use MATLAB or a calculator to perform the matrix multiplications, but write out all of the matrices.