1. Compute dimensions:
   (a) P_5 (b) $\{ \vec{x} \in \mathbb{R}^4 \mid x_1 + x_2 + x_3 + x_4 = 0 \}$
   (c) col A where $n \times n$ A is invertible
   (d) col A, where 3×3 A has Nul $A = $ Span $\left\{ \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix} \right\}$
   (e) Span $\left\{ \begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix}, \begin{pmatrix} 4 \\ 5 \\ 6 \end{pmatrix}, \begin{pmatrix} 7 \\ 8 \\ 9 \end{pmatrix} \right\}$
   (f) im T and ker T of $T: P_3 \to P_3$, $T(p(x)) = p(x) - x p'(x)$
   (g) $\left\{ A \in M_{2 \times 2} \mid \begin{pmatrix} 1 & 2 \\ 2 & 1 \end{pmatrix} A = A \begin{pmatrix} 1 & 2 \\ 2 & 1 \end{pmatrix} \right\}$
   (h) Nul $\begin{pmatrix} 1 & 2 & 3 & 4 \\ 1 & 2 & 3 & 5 \end{pmatrix}$

2. Let $\mathcal{B} = (1 \quad x \quad \frac{1}{2}(3x^2 - 1))$. Find coordinates for
   (a) 1   (b) x   (c) x^2 (d) $\frac{1}{2}(x^2 + x)$ (e) $x^2 - x - 1$

3. Let $\mathcal{B} = (\sin x \quad \cos x)$. Find coordinates for $\sin\left(x - \frac{\pi}{4}\right)$

4. Let $\mathcal{B} = \begin{pmatrix} 2 & 0 \\ 1 & 2 \end{pmatrix}$. Find coordinates for $\begin{pmatrix} 1 \\ 1 \end{pmatrix}$.
   Draw a picture illustrating this.

5. If $\dim V = n$, what can you say about m vectors if $m > n$? if $m < n$?