Answers **Lesson 9 Warm Up Quiz**

Math 2B: Applied Linear Algebra

True/False For the problems below, circle T if the answer is true and circle F is the answer is false.

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1. **T** F The transpose of a matrix unit is also a matrix unit.

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2. T **F** Suppose $\mathbf{x} \in \mathbb{R}^n$ and $\mathbf{b} \in \mathbb{R}^m$The matrix given by the outer product $\mathbf{x}\mathbf{b}^T$ is an $m \times n$ matrix.

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3. **T** F The transpose of a square $n \times n$ shear matrix $S_{ik}(c)$ is also a shear matrix given by $S_{ki}(c) = (S_{ik}(c))^T$.

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4. **T** F Let $\mathbf{e}_j = I_n(:, j) \in \mathbb{R}^n$ be the jth column of the identify matrix $I_n \in \mathbb{R}^{n \times n}$ for all $j = 1, 2, ..., n$. If $i, k \in [n]$ with $i \neq k$, then the shear matrix

$$S_{ik}(c) = I_n + c\ \mathbf{e}_i\, \mathbf{e}_k^T.$$

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5. **T** F Let $\mathbf{e}_k = I_n(:, k) \in \mathbb{R}^n$ be the kth column of the identify matrix $I_n \in \mathbb{R}^{n \times n}$ for all $k = 1, 2, ..., n$. If $j \in \{1, 2, 3, ..., n\}$, then the dilation matrix

$$D_j(c) = I_n + (c - 1)\ \mathbf{e}_j\, \mathbf{e}_j^T$$

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6. **T** F For matrices in $\mathbb{R}^{4 \times 4}$, $D_3(6) - D_3(5) = \mathbf{e}_3 \cdot \mathbf{e}_3^T$

Multiple Choice

For the problems below, circle the correct response for each question.

1. If $A \in \mathbb{R}^{4\times 6}$, how many rows does the matrix A^T have?

   A. 4 **B. 6** C. 0 D. 1 E. None of these.

2. Consider the following expression:

$$\begin{bmatrix} 9 & 5 & 3 \\ 8 & 0 & 2 \\ 7 & -6 & 1 \end{bmatrix} - \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} \begin{bmatrix} 0 & 0 & 6 \end{bmatrix} + \begin{bmatrix} 0 \\ 2 \\ 0 \end{bmatrix} \begin{bmatrix} -5 & 2 & 0 \end{bmatrix}$$

   Using the properties of matrix-matrix multiplication and matrix-matrix addition, which of the following represents the given expression:

   A. $\begin{bmatrix} 9 & 5 & 3 \\ 8 & 0 & 2 \\ 7 & -6 & 1 \end{bmatrix}$ B. $\begin{bmatrix} 3 & 5 & 3 \\ -2 & 4 & 2 \\ 7 & -6 & 1 \end{bmatrix}$ C. $\begin{bmatrix} 9 & 5 & -3 \\ 18 & 4 & 2 \\ 7 & -6 & 1 \end{bmatrix}$ D. $\begin{bmatrix} 9 & 5 & -3 \\ -2 & -4 & 2 \\ 7 & -6 & 1 \end{bmatrix}$ **E.** $\begin{bmatrix} 9 & 5 & -3 \\ -2 & 4 & 2 \\ 7 & -6 & 1 \end{bmatrix}$

3. Suppose that $\mathbf{e}_k \in \mathbb{R}^3$ is the 3×1 elementary basis vector with $\mathbf{e}_k = I_3(:, k)$ for $k = 1, 2, 3$. Let

$$A = -2 \cdot \mathbf{e}_3 \cdot \mathbf{e}_1^T + 4 \cdot \mathbf{e}_2 \cdot \mathbf{e}_2^T + 3 \cdot \mathbf{e}_3 \cdot \mathbf{e}_3^T - \mathbf{e}_1 \cdot \mathbf{e}_2^T$$

   Then, which of the following gives $A(:, 2) \cdot A(1, :)$?

   A. $\begin{bmatrix} 0 & -1 & 0 \\ 0 & 4 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ B. 4 C. 1 **D.** $\begin{bmatrix} 0 & 1 & 0 \\ 0 & -4 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ E. $\begin{bmatrix} 0 & 1 & 0 \\ 0 & 4 & 0 \\ 0 & 0 & 0 \end{bmatrix}$

4. Define the matrix $B \in \mathbb{R}^{3\times 3}$ as a sum of elementary matrices given by

$$B = D_1(2) + S_{21}(2) + S_{31}(3) - S_{13}(-4).$$

   Which of the following matrices is equivalent to B?

   A. $\begin{bmatrix} 3 & 0 & 4 \\ 2 & 2 & 0 \\ 3 & 0 & 2 \end{bmatrix}$ B. $\begin{bmatrix} 2 & 0 & 4 \\ 2 & 1 & 0 \\ 3 & 0 & 1 \end{bmatrix}$ C. $\begin{bmatrix} 2 & 0 & -4 \\ 2 & 1 & 0 \\ 3 & 0 & 1 \end{bmatrix}$ D. $\begin{bmatrix} 4 & 0 & 4 \\ 2 & 2 & 0 \\ 3 & 0 & 2 \end{bmatrix}$ E. $\begin{bmatrix} 3 & 0 & -4 \\ 2 & 2 & 0 \\ 3 & 0 & 2 \end{bmatrix}$