For all questions, answer choice "E) NOTA" means none of the above answers is correct.

1. Evaluate: $\begin{bmatrix} 6 & 7 \\ 2 & 1 \end{bmatrix} - \begin{bmatrix} 5 & -2 \\ 3 & 4 \end{bmatrix}\begin{bmatrix} 1 & 4 \\ 2 & -1 \end{bmatrix}$

A) $\begin{bmatrix} 2 & 0 \\ 0 & 5 \end{bmatrix}$
  B) $\begin{bmatrix} 5 & -15 \\ -9 & -7 \end{bmatrix}$
  C) $\begin{bmatrix} 9 & 1 \\ -3 & 14 \end{bmatrix}$
  D) $\begin{bmatrix} -5 & 4 \\ -2 & -7 \end{bmatrix}$
  E) NOTA

2. Given $\begin{bmatrix} a & b & c \\ d & e & f \\ g & h & i \end{bmatrix} = \begin{bmatrix} 4 & 11 & 6 \\ 7 & 4 & 2 \\ 8 & -3 & 9 \end{bmatrix} \cdot \begin{bmatrix} 3 & 1 & 1 \\ -2 & 7 & 8 \\ 4 & 6 & 5 \end{bmatrix}$, find the value of $b-a-e-i$.

A) 13   B) 17   C) 24   D) 27   E) NOTA

3. Determine the area enclosed by the parallelogram spanned by the vectors $\vec{u} = \langle 3,2,2 \rangle$ and
   $\vec{v} = \langle 1,-4,5 \rangle$.

A) $\sqrt{593}$ B) $\sqrt{689}$ C) $4\sqrt{46}$ D) $2\sqrt{218}$ E) NOTA

4. Find the sum of the real values of x such that $\vec{u} = \left\langle e^{3x/2}, e^{x}, 2e^{x/2}, 1 \right\rangle$ and
   $\vec{v} = \left\langle e^{3x/2}, -e^{x}, -e^{x/2}, 2 \right\rangle$ are perpendicular.

A) $\ln\sqrt{2}$ B) $\ln 3$ C) $\ln\sqrt{5}$ D) $\ln 6$ E) NOTA

5. Given that A and B are invertible 3×3 matrices, which of the following is equivalent to
   $\left((AB)^T \right)^{-1}$?

A) $\left((A^{-1})(B^{-1}) \right)^{T}$ B) $\left((BA)^{T} \right)^{-1}$ C) $\left((A^{T})(B^{T}) \right)^{-1}$ D) $(A^{T})^{-1}(B^{T})^{-1}$ E) NOTA

6. Find the unit vector in the direction of the vector $\langle 8,-6 \rangle$.

A) $\left\langle -\dfrac{3}{\sqrt{10}}, \dfrac{1}{\sqrt{10}} \right\rangle$ B) $\left\langle \dfrac{4}{5}, -\dfrac{3}{5} \right\rangle$ C) $\left\langle -\dfrac{1}{\sqrt{10}}, \dfrac{3}{\sqrt{10}} \right\rangle$ D) $\left\langle -\dfrac{4}{\sqrt{53}}, \dfrac{7}{\sqrt{53}} \right\rangle$ E) NOTA

7. Find the solution to the system of equations $\begin{cases} 2x+5y-3z=8 \\ 5x-y+2z=3 \\ x+2y-z=6 \end{cases}$.

A) $\left(-\dfrac{13}{4},\dfrac{53}{4},\dfrac{69}{4}\right)$ B) $\left(-\dfrac{11}{4},\dfrac{57}{4},\dfrac{79}{4}\right)$ C) $\left(-\dfrac{17}{4},\dfrac{51}{4},\dfrac{75}{4}\right)$ D) $\left(-\dfrac{15}{4},\dfrac{55}{4},\dfrac{71}{4}\right)$ E) NOTA

8. Which of the following matrices is singular?

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

9. Solve for matrix A in the equation $A\begin{bmatrix} -2 & 3 \\ 5 & 1 \end{bmatrix}=17\begin{bmatrix} 4 & -1 \\ 6 & 5 \end{bmatrix}$.

A) $\begin{bmatrix} -6 & 14 \\ 5 & 10 \end{bmatrix}$ B) $\begin{bmatrix} -9 & 10 \\ 19 & 28 \end{bmatrix}$ C) $\begin{bmatrix} -11 & 13 \\ 7 & 26 \end{bmatrix}$ D) $\begin{bmatrix} -12 & 32 \\ 16 & 7 \end{bmatrix}$ E) NOTA

10. Let θ be the smaller angle formed by the vectors $\langle 3,1,-4\rangle$ and $\langle 2,-1,5\rangle$. What is the value of $\tan^2\theta-1$?

A) $\dfrac{13}{15}$ B) $\dfrac{22}{15}$ C) $\dfrac{28}{15}$ D) $\dfrac{32}{15}$ E) NOTA

11. Which of the following planes is perpendicular to the plane $4x-3y+2z=11$?

A) $-x+2y+z=9$ B) $7x-y-z=4$ C) $x+2y+z=2$ D) $3x+y-5z=2$ E) NOTA

12. Find the trace of the matrix $\begin{bmatrix} \ln 5 & 23 & \ln 6 \\ 2 & -\ln 3 & 8 \\ 7 & \ln 2 & e^2 \end{bmatrix}$.

A) $\ln\left(5e/3\right)$ B) $\ln\left(5e^e/3\right)$ C) $\ln\left(5e^{e^2}/3\right)$ D) $\ln\left(5e^{e^{e^2}}/3\right)$ E) NOTA

13. Evaluate: $\begin{vmatrix} 2 & -3 & 0 & -2 \\ 3 & -1 & 1 & 1 \\ -2 & 1 & -1 & 0 \\ 0 & 3 & 1 & 2 \end{vmatrix}$

A) 0   B) 1   C) 2   D) 3   E) NOTA

14. Which of the following describes the matrix $\begin{bmatrix} 0 & 3 & -5 \\ -3 & 0 & -1 \\ 5 & 1 & 0 \end{bmatrix}$?

A) invertible   B) symmetric   C) skew-symmetric   D) radial   E) NOTA

15. Find the product of the real values of x that make the matrix $\begin{bmatrix} x^2-4 & x+2 \\ 2 & x+3 \end{bmatrix}$ singular?

A) 4   B) 8   C) 12   D) 16   E) NOTA

16. A solid rectangular prism lies in the 3D coordinate system such that one of its vertices is at the origin and two connecting edges are formed by the vectors $\langle 0,8,0 \rangle$ and $\langle 4,0,0 \rangle$. If the volume of the prism is 64 cubic units, find the length of the longest diagonal of the prism.

A) $2\sqrt{21}$ B) $4\sqrt{21}$ C) $8\sqrt{21}$ D) $16\sqrt{21}$ E) NOTA

17. Given that $\vec{a}=\langle 3,-5 \rangle$ and $\vec{b}=\langle -6,2 \rangle$, find the vector that is the projection of $\vec{a}$ onto $\vec{b}$.

A) $\left\langle -\dfrac{34}{5},-\dfrac{9}{5} \right\rangle$ B) $\left\langle \dfrac{21}{5},-\dfrac{7}{5} \right\rangle$ C) $\left\langle -\dfrac{14}{5},-\dfrac{4}{5} \right\rangle$ D) $\left\langle -\dfrac{9}{5},-\dfrac{1}{5} \right\rangle$ E) NOTA

18. Find the length of the vector $\langle \sin 23^\circ, \sin 42^\circ, \sin 48^\circ, \sin 67^\circ \rangle$

A) $\dfrac{\sqrt{2}}{2}$ B) $\sqrt{2}$ C) π D) e E) NOTA

19. If $\vec{a}=\langle 0,0,-3 \rangle$ and $\vec{b}=\langle 0,2,0 \rangle$, in what direction is the vector $\vec{a} \times \vec{b}$?

A) positive x-axis   B) negative y-axis   C) z-axis   D) it is the zero vector   E) NOTA

20. Compute and simplify: $\begin{vmatrix} \cos 2x & -1 \\ i\sin 2x & 1 \end{vmatrix}$

A) e^{ix} B) e^{2ix} C) e^{3ix} D) e^{4ix} E) NOTA

21. Which of the following is equivalent to $\begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 2 \end{bmatrix}^{2011}$, where I is the 3×3 identity

   matrix?

A) $2^{2010} I$ B) $2^{2011} I$ C) $2^{2012} I$ D) $2^{2013} I$ E) NOTA

22. Given that $\vec{a} = \langle 2, -1, 7 \rangle$, $\vec{b} = \langle 0, 2, -1 \rangle$, and $\vec{c} = \langle 4, -3, 5 \rangle$, find the scalar triple product
   $\vec{a} \cdot (\vec{b} \times \vec{c})$.

A) 17   B) –38   C) –26   D) 48   E) NOTA

23. Evaluate: $\begin{bmatrix} 10.8 & 4.1 \\ 62.4 & 39.3 \end{bmatrix} + \begin{bmatrix} 1072.3 & 2.4 \\ 21.8 & 96.1 \end{bmatrix}$

A) $\begin{bmatrix} 1093.1 & 7.5 \\ 24.2 & 35.4 \end{bmatrix}$ B) $\begin{bmatrix} 1083.1 & 6.5 \\ 84.2 & 135.4 \end{bmatrix}$ C) $\begin{bmatrix} 1083.1 & 9.5 \\ 64.2 & 1305.4 \end{bmatrix}$ D) $\begin{bmatrix} 183.1 & 6.5 \\ 4.2 & 105.4 \end{bmatrix}$
E) NOTA

24. Given that A is a square matrix such that $|A| = 36$, find $|A^T|$.

A) –36   B) $\frac{1}{36}$ C) 36   D) 1296   E) NOTA

25. Given that $A = \begin{bmatrix} -3 & 2 \\ 7 & 5 \end{bmatrix}$ and $B = \begin{bmatrix} 6 & 4 \\ -2 & 3 \end{bmatrix}$, find the product $A^{-1}B^{-1}$.

A) $-\frac{1}{764}\begin{bmatrix} 11 & -32 \\ -27 & 10 \end{bmatrix}$ B) $\frac{1}{764}\begin{bmatrix} 11 & -32 \\ -27 & 10 \end{bmatrix}$ C) $-\frac{1}{754}\begin{bmatrix} 11 & -32 \\ -27 & 10 \end{bmatrix}$ D) $\frac{1}{754}\begin{bmatrix} 11 & -32 \\ -27 & 10 \end{bmatrix}$
E) NOTA

26. Which of the following matrices can be used to rotate a point or vector through an angle of $60°$ counterclockwise?

A) $\begin{bmatrix} -\frac{1}{2} & -\frac{\sqrt{3}}{2} \\ -\frac{\sqrt{3}}{2} & \frac{1}{2} \end{bmatrix}$
   B) $\begin{bmatrix} \frac{1}{2} & -\frac{\sqrt{3}}{2} \\ \frac{\sqrt{3}}{2} & -\frac{1}{2} \end{bmatrix}$
   C) $\begin{bmatrix} -\frac{1}{2} & \frac{\sqrt{3}}{2} \\ \frac{\sqrt{3}}{2} & \frac{1}{2} \end{bmatrix}$
   D) $\begin{bmatrix} \frac{1}{2} & -\frac{\sqrt{3}}{2} \\ \frac{\sqrt{3}}{2} & \frac{1}{2} \end{bmatrix}$

E) NOTA

27. What is the magnitude of the vector $6\vec{i} - 4\vec{j} + 3\vec{k}$?

A) $\sqrt{61}$ B) 6   C) 72   D) $\langle 6,-4,3 \rangle$ E) NOTA

28. What is the minimum value of the determinant $|AB|$ if $A = \begin{bmatrix} x & -3 \\ 2 & 1 \end{bmatrix}$ and $B = \begin{bmatrix} 4 & -x \\ 1 & 2 \end{bmatrix}$?

A) –1   B) –6   C) –8   D) 8   E) NOTA

29. How many of the following products are defined for matrices A, B, C, and D with respective dimensions 2×2, 3×2, 2×3, and 4×3 ?
   I) AB II) CB III) DB IV) BC V) DC

A) 1   B) 2   C) 3   D) 4   E) NOTA

30. Find the value of x such that the matrix $\begin{bmatrix} 3 & 4 \\ x & -3 \end{bmatrix}$ is its own inverse.

A) –3   B) –1   C) 1   D) 3   E) NOTA