For all items, answer E, NOTA means "none of the above is correct." Unless otherwise stated, "i" is to be interpreted as $\sqrt{-1}$.

1. Let $A=\begin{bmatrix}0&-1\\1&2\end{bmatrix}$ and $B=\begin{bmatrix}1&-2\\0&3\\-3&1\end{bmatrix}$, find AB^T.

A. $\begin{bmatrix}-3&2\\6&-3\\-1&-1\end{bmatrix}$ B. $\begin{bmatrix}-2&3&1\\-5&6&5\end{bmatrix}$ C. $\begin{bmatrix}2&-3&-1\\-3&6&-1\end{bmatrix}$ D. $\begin{bmatrix}-2&-5\\3&6\\1&5\end{bmatrix}$ E. NOTA

Given that an orthogonal matrix is a square matrix A for $AA^T=A^TA=I$. (Use for #2 only)

2. For what absolute values of (a, b) would matrix A be orthogonal? $A=\begin{bmatrix}1&a\\0&b\end{bmatrix}$.

A. (1, 1) B. (0, 0) C. (1, 0) D. (0, 1) E. NOTA

3. Find the value of $\begin{vmatrix}1&2&-3&0\\-2&1&0&3\\0&4&-4&-1\\0&-1&2&5\end{vmatrix}$.

A. 16 B. 28 C. 36 D. 42 E. NOTA

4. Given $\begin{bmatrix}1&3&x^2+2x\\8&-5&27\end{bmatrix}=\begin{bmatrix}5^0&\sqrt[3]{27}&8\\2*4&x+y&3^3\end{bmatrix}$, for a positive value of x, what is xy?

A. 4 B. -6 C. 8 D. -12 E. NOTA

5. Find the area of the triangle with the vertices at (2, -3); (3, -5); and (1, 4).

A. 5 B. $\frac{5}{2}$ C. -5 D. 7 E. NOTA

6. For the determinant $\begin{vmatrix}x&0&c\\-1&x&b\\0&-1&a\end{vmatrix}=0$, let P be the product of roots of x and S be the sum of roots of x, find P-S.

A. $ab + c$ B. $\frac{c-2b}{2a}$ C. $\frac{c+b}{a}$ D. $2cb - a$ E. NOTA

7. Given that matrix $A = \begin{bmatrix} -5 & 9 & 3 \\ 4 & -2 & 0 \\ 7 & 6 & -1 \end{bmatrix}$, find the value of the minor of $a_{(2,3)}$

A. 0 B. -93 C. -58 D. -4 E. NOTA

8. Given matrix $A = \begin{bmatrix} 4 & 5 & -1 \\ -3 & 2 & 0 \\ 3 & -2 & 1 \end{bmatrix}$, then $A^{-1} = \frac{1}{b}\begin{bmatrix} 2 & -3 & 2 \\ 3 & 7 & 3 \\ 0 & 1 & 1 \end{bmatrix}$. Find the value of b.

A. 12 B. 23 C. 31 D. -35 E. NOTA

9. Reduce $\begin{bmatrix} 1 & 1 & 3 \\ 2 & 0 & 1 \\ 1 & -1 & -2 \end{bmatrix}$ to row-echelon form.

A. $\begin{bmatrix} 1 & 0 & \frac{1}{2} \\ 0 & 1 & \frac{5}{2} \\ 0 & -1 & -\frac{5}{2} \end{bmatrix}$ B. $\begin{bmatrix} 1 & 0 & \frac{1}{2} \\ 0 & 2 & \frac{5}{2} \\ 0 & 0 & -\frac{5}{2} \end{bmatrix}$ C. $\begin{bmatrix} 1 & 0 & \frac{1}{2} \\ 0 & 1 & \frac{5}{2} \\ 0 & 0 & 0 \end{bmatrix}$ D. $\begin{bmatrix} 1 & 0 & 1 \\ 0 & 2 & \frac{5}{2} \\ 0 & 0 & -\frac{5}{2} \end{bmatrix}$ E. NOTA

10. Find X if $\begin{bmatrix} -2 & -3 \\ 1 & 2 \end{bmatrix} X = \begin{bmatrix} 5 & 3 \\ -2 & 1 \end{bmatrix}$

A. $\begin{bmatrix} 5 & 3 \\ -2 & 1 \end{bmatrix}$ B. $\begin{bmatrix} -3 & -9 \\ 1 & 4 \end{bmatrix}$ C. $\begin{bmatrix} -4 & -9 \\ -1 & 5 \end{bmatrix}$ D. $\begin{bmatrix} -2 & -3 \\ 1 & 2 \end{bmatrix}$ E. NOTA

11. Find the value of y which makes $\begin{bmatrix} 1 & 4 & 2 \\ 3 & 3 & 2 \\ -1 & y & 0 \end{bmatrix}$ a singular matrix.

A. $\frac{3}{4}$ B. 2 C. $\frac{1}{2}$ D. 3 E. NOTA

12. The matrix $\begin{bmatrix} \frac{1}{2} & -\frac{\sqrt{3}}{2} \\ \frac{\sqrt{3}}{2} & \frac{1}{2} \end{bmatrix}$ can be used to rotate points in the plane about the origin through the angle of...

A. 30° clockwise B. 30° counterclockwise E. NOTA

C. 45° clockwise D. 45° counterclockwise

13. The value of $det\begin{bmatrix} 2\boldsymbol{i} & -\boldsymbol{i} & 3 \\ \boldsymbol{i} & 4 & -2 \\ -3 & \boldsymbol{i} & 4 \end{bmatrix} = a + b\boldsymbol{i}$. Find $2a - 3b$.

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A. -2 B. - 8 C. -22 D. -28 E. NOTA

14. For $\begin{Bmatrix} 2x+y-3=1 \\ x+2y-z=2 \\ -y-z=-3 \end{Bmatrix}$, if the solution for the variable "z" is written using Cramer's rule, the numerator would be:

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

15. Which of the following matrices is (are) singular? ($x, y \neq 0$)

I. $\begin{bmatrix} x & x \\ y & y \end{bmatrix}$ II. $\begin{bmatrix} -1 & 0 \\ 1 & 0 \end{bmatrix}$ III. $\begin{bmatrix} x & -y \\ x & y \end{bmatrix}$ IV. $\begin{bmatrix} 1 & -1 \\ 1 & 0 \end{bmatrix}$ V. $\begin{bmatrix} x & 1 \\ x & 1 \end{bmatrix}$

A. III, IV B. II, IV C. I, V D. III E. NOTA

16. Find the eigenvalue(s) of $A = \begin{bmatrix} 1 & 3 \\ 3 & 1 \end{bmatrix}$.

A. 2 B. -3, 1 C. -2, 4 D. 10 E. NOTA

17. Matrix A has 2 rows, 4 columns. Matrix B has 4 rows, 3 columns. The existing product of these two matrices will consist of P elements. What is the value of P?

A. 6 B. 8 C. 12 D. 16 E. NOTA

18. Find the smallest real value of K so that the system of equations below has no solution.

$$x - y + 2z = 1$$
$$3x - y + 2z = 0$$
$$x + 2y - Kz = 0$$

A. 4 B. -2 C. -7 D. 2 E. NOTA

19. What is the distance between the point (4, 3, 1) and the plane $2x + y - 2z + 3 = 0$?

A. 6 B. 8 C. $\frac{12}{\sqrt{26}}$ D. 4 E. NOTA

20. Evaluate: $\left(\begin{bmatrix} 1 & 4 \\ 2 & 3 \\ 3 & 2 \end{bmatrix} \bullet \begin{bmatrix} 1 & 0 & 2 \\ 2 & 3 & 1 \end{bmatrix}\right)^T$

A. $\begin{bmatrix} 9 & 12 & 6 \\ 8 & 9 & 7 \\ 7 & 6 & 8 \end{bmatrix}$ B. $\begin{bmatrix} 9 & 8 & 7 \\ 12 & 9 & 7 \\ 6 & 6 & 8 \end{bmatrix}$ C. $\begin{bmatrix} 9 & 8 & 7 \\ 12 & 9 & 6 \\ 6 & 7 & 8 \end{bmatrix}$ D. $\begin{bmatrix} 1 & 0 & 2 \\ 1 & 2 & 3 \end{bmatrix}$ E. NOTA

21. Matrix A is multiplied by its multiplicative inverse. The result is

A. I B. A^{-1} C. $2A$ D. A^2 E. NOTA

22. Using Cramer's Rule to solve a system of equations involving variables a, b, c, and d, the variable c is found to equal $\frac{0}{0}$. This system has

A. No solutions
B. One solution, an imaginary number
C. Infinite solutions
D. One solution, not necessarily an imaginary number
E. NOTA

23. Translate the system $\begin{matrix} 3x + 2y = 5 \\ 2x - 4y = 5 \end{matrix}$ into a matrix equation.

A. $\begin{bmatrix} 3x \\ 2x \end{bmatrix} + \begin{bmatrix} 2y \\ -4y \end{bmatrix} = 5$ B. $\begin{bmatrix} -4x \\ 2y \end{bmatrix} + \begin{bmatrix} 2x \\ 3y \end{bmatrix} = 5$ E. NOTA

C. $\begin{bmatrix} 3x \\ 2x \end{bmatrix}\begin{bmatrix} 2y \\ -4y \end{bmatrix} = \begin{bmatrix} 5 \\ 5 \end{bmatrix}$ D. $\begin{bmatrix} 3 & 2 \\ 2 & -4 \end{bmatrix}\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 5 \\ 5 \end{bmatrix}$

24. Evaluate $\begin{bmatrix} 1 & -1 \\ 1 & 1 \end{bmatrix}^{11}$.

A. $\begin{bmatrix} 16 & 0 \\ 0 & -16 \end{bmatrix}$ B. $\begin{bmatrix} 0 & 16 \\ -16 & 0 \end{bmatrix}$ C. $\begin{bmatrix} -32 & -32 \\ 32 & -32 \end{bmatrix}$ D. $\begin{bmatrix} 20 & 0 \\ -20 & -20 \end{bmatrix}$ E. NOTA

25. Suppose the 3x3 matrix A has a determinant of 3. What is the determinant of $3A$?

A. 9 B. 27 C. 81 D. 243 E. NOTA

26. What is the element in the second row, third column of the inverse of the matrix $A = \begin{bmatrix} 1 & 2 & 3 \\ 0 & 4 & 5 \\ 1 & 0 & 6 \end{bmatrix}$?

A. $-\frac{5}{22}$ B. $\frac{1}{11}$ C. $-\frac{6}{11}$ D. $\frac{5}{22}$ E. NOTA

27. Evaluate $\begin{bmatrix} 1 & 2 \\ -4 & 0 \end{bmatrix}\begin{bmatrix} 0 & 1 \\ -2 & 2 \\ 1 & 3 \end{bmatrix}$.

A. $\begin{bmatrix} -9 & 13 \\ 14 & -20 \end{bmatrix}$ B. $\begin{bmatrix} -9 & 13 \\ 16 & -35 \\ -4 & 24 \end{bmatrix}$ C. $\begin{bmatrix} -9 & 13 & -4 \\ 14 & -20 & 24 \end{bmatrix}$ D. $\begin{bmatrix} -9 & 13 & 16 \\ 14 & -20 & -35 \\ -4 & 24 & 0 \end{bmatrix}$ E. NOTA

28. $\begin{vmatrix} 3 & 2 \\ -3 & a \end{vmatrix} = \begin{vmatrix} -1 & 3 \\ 6 & 6 \end{vmatrix}$, what is the value of a?

A. $\frac{7}{3}$ B. -10 C. $\frac{11}{3}$ D. 5 E. NOTA

29. If $\begin{vmatrix} 2 & -3 & 1 \\ x & 1 & 2 \\ 0 & -2 & x \end{vmatrix} = 20$, find value or the sum of the values of x.

A. -2 B. -1 C. 0 D. 2 E. NOTA

30. Find the inverse of $\begin{bmatrix} i & \pi \\ e & 1 \end{bmatrix}$.

A. $\begin{bmatrix} 1 & \pi \\ e & i \end{bmatrix}$ B. $\begin{bmatrix} 1 & -\pi \\ -e & i \end{bmatrix}$ C. $\frac{1}{i - e\pi}\begin{bmatrix} -1 & \pi \\ e & -i \end{bmatrix}$ D. $\frac{1}{e\pi - i}\begin{bmatrix} -1 & \pi \\ e & -i \end{bmatrix}$ E. NOTA

Tiebreakers:

1. How many directed paths in the matrix $\begin{bmatrix} 1 & 0 & 2 \\ 0 & 0 & 3 \\ 2 & 1 & 0 \end{bmatrix}$.

2. Simplify: $\begin{bmatrix} 3 & -2 & 5 \end{bmatrix} \bullet \begin{bmatrix} 4 \\ 6 \\ 10 \end{bmatrix}$

3. If $\begin{bmatrix} -2 & 1 & 0 \\ 5 & -3 & 1 \end{bmatrix} \bullet \begin{bmatrix} a & 0 \\ 3 & b \\ 2 & -1 \end{bmatrix} = \begin{bmatrix} -3 & 10 \\ 8 & -31 \end{bmatrix}$, find the sum of $a + b$.