

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

1. Evaluate:  $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} + \begin{bmatrix} 5 & 6 \\ 7 & 8 \end{bmatrix}$

A)  $\begin{bmatrix} -4 & -4 \\ -4 & -4 \end{bmatrix}$     B)  $\begin{bmatrix} 6 & 8 \\ 10 & 12 \end{bmatrix}$     C)  $\begin{bmatrix} 19 & 22 \\ 43 & 50 \end{bmatrix}$     D)  $\begin{bmatrix} 7 & 10 \\ 11 & 13 \end{bmatrix}$     E) NOTA

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

A)  $\begin{bmatrix} 3 & 7 & 7 \\ 4 & 5 & 10 \\ 4 & 9 & 9 \end{bmatrix}$     B)  $\begin{bmatrix} 15 & 34 & 46 \\ 16 & 40 & 56 \\ 17 & 38 & 30 \end{bmatrix}$     C)  $\begin{bmatrix} 15 & 34 & 46 \\ 16 & 40 & 57 \\ 17 & 30 & 39 \end{bmatrix}$     D)  $\begin{bmatrix} 15 & 34 & 46 \\ 16 & 40 & 56 \\ 17 & 32 & 38 \end{bmatrix}$     E) NOTA

3. If  $x^3 - 2x^2 - 9x + 18 = 0$  and  $A = \begin{vmatrix} 1 & 2 & 3 \\ 4 & x & 6 \\ 7 & 8 & 9 \end{vmatrix}$ , what is the maximum value of  $A$ ?

A) 96    B) 36    C) 24    D) 120    E) NOTA

4. If  $A = \begin{bmatrix} 1 & 2 \\ 5 & 9 \end{bmatrix}$ , then  $A^{-1} = ?$

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

5. If  $A$  is a  $3 \times 3$  matrix with  $|A| = 8$ , then what is the value of  $|3A|$ ?

A) 8    B) 24    C) 72    D) 216    E) NOTA

6. What is the trace of the matrix  $\begin{bmatrix} 1 & 3 & 5 & 4 \\ 1 & 2 & 7 & 8 \\ 2 & 4 & 3 & 9 \\ 6 & 7 & 0 & 4 \end{bmatrix}$ ?

A) 9    B) 10    C) 24    D) 14    E) NOTA

For questions 7-9, use the matrix  $F = \begin{bmatrix} 1 & 2 & 10 \\ 3 & 0 & 2 \\ 0 & 1 & 5 \end{bmatrix}$ .

7. What is the value of  $F_{1,3}$ ?

- A) 2                      B) 5                      C) 10                      D) 1                      E) NOTA

8. What is  $F^T$ ?

- A)  $\begin{bmatrix} -1 & -2 & -10 \\ -3 & 0 & -2 \\ 0 & -1 & -5 \end{bmatrix}$       B)  $\begin{bmatrix} 0 & 1 & 5 \\ 3 & 0 & 2 \\ 1 & 2 & 10 \end{bmatrix}$       C)  $\begin{bmatrix} 10 & 2 & 1 \\ 2 & 0 & 3 \\ 5 & 1 & 0 \end{bmatrix}$       D)  $\begin{bmatrix} 1 & 3 & 0 \\ 2 & 0 & 1 \\ 10 & 2 & 5 \end{bmatrix}$       E) NOTA

9. What is  $F^{-1}$ ?

- A)  $\begin{bmatrix} 1 & 0 & -2 \\ 7.5 & -2.5 & -14 \\ -1.5 & 0.5 & 3 \end{bmatrix}$       B)  $\begin{bmatrix} -2 & -15 & 3 \\ 0 & 5 & -1 \\ 4 & 28 & -6 \end{bmatrix}$       C)  $\begin{bmatrix} -2 & 0 & 4 \\ -15 & 5 & 28 \\ 3 & -1 & -6 \end{bmatrix}$       D)  $\begin{bmatrix} 1 & 7.5 & -1.5 \\ 0 & -2.5 & 0.5 \\ -2 & -14 & 3 \end{bmatrix}$   
E) NOTA

10. Given that the matrix  $\begin{bmatrix} 2 & 4 & 9 \\ 6 & 3 & x \\ 1 & 1 & 5 \end{bmatrix}$  is singular, what is the value of  $x$ ?

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

11. What is the adjoint of the matrix  $\begin{bmatrix} 3 & 4 & 2 \\ 2 & 1 & 7 \\ 9 & 4 & 2 \end{bmatrix}$ ?

- A)  $\begin{bmatrix} -26 & 59 & -1 \\ 0 & -12 & 24 \\ 26 & -17 & -5 \end{bmatrix}$       B)  $\begin{bmatrix} 26 & -59 & 1 \\ 0 & 12 & -24 \\ -26 & 17 & 5 \end{bmatrix}$       C)  $\begin{bmatrix} -26 & 0 & 26 \\ 59 & -12 & -17 \\ -1 & 24 & -5 \end{bmatrix}$       D)  $\begin{bmatrix} 26 & 0 & -26 \\ -59 & 12 & 17 \\ 1 & -24 & 5 \end{bmatrix}$   
E) NOTA

12. What is the determinant of the matrix  $\begin{bmatrix} 1 & 2 & 3 & 4 & 5 \\ 0 & 2 & 4 & 6 & 8 \\ 0 & 0 & 3 & 6 & 9 \\ 0 & 0 & 0 & 4 & 8 \\ 0 & 0 & 0 & 0 & 5 \end{bmatrix}$ ?

- A) 15                      B) 120                      C) 60                      D) 30                      E) NOTA

13. What value of  $x$  will make the matrix  $\begin{bmatrix} -1 & x \\ -1 & x \end{bmatrix}$  idempotent?

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

14. What are the eigenvalues of the matrix  $\begin{bmatrix} 3 & 1 \\ 3 & 5 \end{bmatrix}$ ?

- A) 2 only                      B) -2 only                      C) 6 only                      D) 2 and 6                      E) NOTA

15. If  $A^{-1} = \begin{bmatrix} 1 & 2 & 5 \\ 4 & 3 & 9 \\ 7 & 8 & 2 \end{bmatrix}$  and  $B^{-1} = \begin{bmatrix} 2 & 0 & 3 \\ 4 & 1 & 2 \\ 7 & 8 & 0 \end{bmatrix}$ , then  $(AB)^{-1} = ?$

- A)  $\begin{bmatrix} 3 & 2 & 8 \\ 8 & 4 & 11 \\ 14 & 16 & 2 \end{bmatrix}$     B)  $\begin{bmatrix} -1 & 2 & 2 \\ 0 & 2 & 7 \\ 0 & 0 & 2 \end{bmatrix}$     C)  $\begin{bmatrix} 45 & 42 & 7 \\ 83 & 75 & 18 \\ 60 & 24 & 37 \end{bmatrix}$     D)  $\begin{bmatrix} 23 & 28 & 16 \\ 22 & 27 & 33 \\ 39 & 38 & 107 \end{bmatrix}$     E) NOTA

16. If  $A$  is a  $5 \times 7$  matrix,  $B$  is a  $3 \times 7$  matrix, and  $C$  is a  $3 \times 5$  matrix, then which of the following matrices is defined?

- A)  $AB$                       B)  $BC$                       C)  $(AB)^T$                       D)  $CA$                       E) NOTA

17. What is the determinant of the matrix  $\begin{bmatrix} 1 & 2 & 5 & 7 \\ 0 & 4 & 3 & 1 \\ 2 & 4 & 9 & 0 \end{bmatrix}$ ?

- A) -87                      B) 38                      C) -38                      D) 0                      E) NOTA

18. If  $A^T = \begin{bmatrix} 1 & 2 & 0 \\ 3 & 4 & 1 \\ 7 & 8 & 5 \end{bmatrix}$  and  $B^T = \begin{bmatrix} 1 & 3 & 5 \\ 7 & 8 & 2 \\ 4 & 0 & 1 \end{bmatrix}$ , then  $(AB)^T = ?$

A)  $\begin{bmatrix} 45 & 54 & 28 \\ 45 & 62 & 18 \\ 11 & 16 & 5 \end{bmatrix}$     B)  $\begin{bmatrix} 2 & 5 & 5 \\ 10 & 12 & 3 \\ 11 & 8 & 6 \end{bmatrix}$     C)  $\begin{bmatrix} 0 & -1 & -5 \\ -4 & -4 & -1 \\ 3 & 8 & 4 \end{bmatrix}$     D)  $\begin{bmatrix} 15 & 19 & 9 \\ 35 & 41 & 24 \\ 83 & 85 & 56 \end{bmatrix}$     E) NOTA

19. What is the value of  $w$  in the system of equations  $\begin{cases} 4v + w + 3x = 1 \\ 3v + 2w + 4x = 2 \\ 6v + 4w + x = 6 \end{cases}$ ?

A)  $-\frac{2}{7}$     B)  $\frac{2}{7}$     C)  $\frac{4}{35}$     D)  $\frac{7}{5}$     E) NOTA

20. If  $\begin{vmatrix} a & b & c \\ d & e & f \\ g & h & i \end{vmatrix} = 36$ , then what is the value of  $\begin{vmatrix} g & h & i \\ d & e & f \\ a & b & c \end{vmatrix}$ ?

A) 36    B) -36    C) 18    D) -18    E) NOTA

21. What value of  $x$  will make the matrix  $\begin{bmatrix} 1 & 2 & 4 \\ 2 & 3 & 0 \\ 4 & x & 6 \end{bmatrix}$  symmetric?

A) 6    B) 4    C) 3    D) 2    E) NOTA

22. Which of the following types of matrices will always have a trace of 0?

A) square    B) skew-symmetric    C) symmetric    D) singular    E) NOTA

23. Which of the following describes the matrix  $\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$ ?

I) singular    II) idempotent    III) skew-symmetric    IV) square

A) I, II, & IV only    B) II, III, & IV only    C) II & IV only    D) I & IV only    E) NOTA

24. What is the value of  $|A^{-1}|$ , given that  $A = \begin{bmatrix} 1 & 0 & 2 \\ 3 & 1 & 4 \\ 5 & 6 & 0 \end{bmatrix}$ ?

- A)  $\frac{1}{2}$       B)  $-\frac{1}{2}$       C)  $\frac{1}{4}$       D)  $-\frac{1}{4}$       E) NOTA

25. What is the sum of the entries of the matrix  $\begin{bmatrix} 1 & 2 & 4 & 9 \\ 8 & 7 & 3 & 0 \\ 3 & 4 & 6 & 9 \\ 1 & 4 & 7 & 3 \end{bmatrix}$ ?

- A) 69      B) 70      C) 71      D) 72      E) NOTA

26. Which of the following do not describe the matrix  $\begin{bmatrix} 1 & 2 & 4 \\ 6 & 7 & 9 \\ 0 & 3 & 5 \end{bmatrix}$ ?

I) skew-symmetric    II) singular    III) symmetric    IV) square

- A) I, II, & IV only    B) I & II only    C) II, III, & IV only    D) III only    E) NOTA

27. If  $\begin{vmatrix} a & b & c \\ d & e & f \\ g & h & i \end{vmatrix} = 10$ , then what is the value of  $\begin{vmatrix} a & b & c \\ d & e & f \\ a+g & b+h & c+i \end{vmatrix}$ ?

- A) 10      B) -10      C) 20      D) -20      E) NOTA

28. How many positive integers satisfy the equation  $\begin{vmatrix} x & 4 & 6 \\ 1 & x & 3 \\ 0 & 7 & 10 \end{vmatrix} = 0$ ?

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

29. What is the value of the determinant of the matrix  $\begin{bmatrix} 1 & 7 \\ 9 & 8 \end{bmatrix}$ ?

- A) 55      B) 71      C) -71      D) -55      E) NOTA

