EXPRESSWALA ACADEMY

Maths 1A: Linear Equations

MCQ Test, Set 03

Time: 30 minutes | Maximum marks: 25

Name: _____ Class: _____ Date: _____

1. There are 25 questions. Each has exactly one correct answer: choose A, B, C or D.
2. Each correct answer carries 1 mark. There is no negative marking.
3. The key sheet and worked solutions are at the end of this test.

1. For $A = \begin{bmatrix} 0 & -3 & -4 \\ 5 & 0 & 2 \\ 2 & 4 & 1 \end{bmatrix}$, the determinant of the submatrix obtained by deleting row 1 and column 3 is

A. 6 **B.** 20 **C.** -20 **D.** 22

2. The rank of $\begin{bmatrix} 1 & -2 & 0 \\ -1 & 2 & 0 \\ 2 & -4 & 0 \end{bmatrix}$ is

A. 2 **B.** 0 **C.** 1 **D.** 3

3. The rank of the echelon matrix $\begin{bmatrix} 3 & 7 & 6 & -3 & -4 \\ 0 & 0 & 0 & 4 & -2 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$ is

A. 2 **B.** 3 **C.** 5 **D.** 1

4. The rank of the echelon matrix $\begin{bmatrix} 0 & 4 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ is

A. 2 **B.** 1 **C.** 3 **D.** 0

5. Using elementary transformations, the rank of $\begin{bmatrix} 1 & 0 & 4 & 3 \\ -1 & 0 & -4 & -3 \\ 2 & 0 & 8 & 6 \end{bmatrix}$ is found to be

A. 1 **B.** 0 **C.** 3 **D.** 2

6. Using elementary transformations, the rank of $\begin{bmatrix} 1 & 1 & -1 & -2 \\ 6 & 8 & 4 & -10 \\ -2 & -3 & -3 & 3 \end{bmatrix}$ is found to be

A. 1 **B.** 3 **C.** 4 **D.** 2

7. A and B are square matrices of order 6 with $\text{rank}(A) = 1$ and $\text{rank}(B) = 3$. The greatest possible value of $\text{rank}(A + B)$ is

A. 6 **B.** 1 **C.** 4 **D.** 3

8. The rank of the 5×4 null matrix is

A. 20 **B.** 1 **C.** 4 **D.** 0

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9. The augmented matrix of the system $4x - 4y + 6z = -4$, $-3y - z = 4$ and $-3x = 11$ is

A. $\left[\begin{array}{ccc|c} -4 & -4 & 6 & 4 \\ 4 & -3 & -1 & 0 \\ 11 & 0 & 0 & -3 \end{array}\right]$

B. $\left[\begin{array}{ccc|c} 4 & -4 & 6 & -4 \\ -3 & -1 & 0 & 4 \\ -3 & 0 & 0 & 11 \end{array}\right]$

C. $\left[\begin{array}{ccc|c} 4 & -4 & 6 & 4 \\ 0 & -3 & -1 & -4 \\ -3 & 0 & 0 & -11 \end{array}\right]$

D. $\left[\begin{array}{ccc|c} 4 & -4 & 6 & -4 \\ 0 & -3 & -1 & 4 \\ -3 & 0 & 0 & 11 \end{array}\right]$

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10. The system $-5x - 4y = -32$ and $7x + 7y = 49$ has

A. no solution **B.** exactly two solutions

C. a unique solution **D.** infinitely many solutions

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11. The system $5x + 4y = -4$ and $15x + 12y = -12$ has

A. infinitely many solutions **B.** no solution

C. exactly two solutions **D.** a unique solution

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12. The system $4x + 7y = 0$, $20x + ky = 0$ has non-trivial solutions when $k =$

A. 35 **B.** -35 **C.** 7 **D.** $\frac{7}{5}$

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13. The system $8x - y = 0$, $48x + ky = 0$ has non-trivial solutions when $k =$

A. 6 **B.** $-\frac{1}{6}$ **C.** -1 **D.** -6

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14. The system $5x + ky + 3z = 0$, $-4x - 6y - 3z = 0$ and $-5x - 3y + 3z = 0$ has a non-trivial solution when $k =$

A. -7 **B.** 7 **C.** 8 **D.** 6

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15. The system $-5x - 4y + 3z = 0$, $-3x + 6y - z = 0$ and $kx - 2y + z = 0$ has a non-trivial solution when $k =$

A. -2 **B.** 0 **C.** 1 **D.** -1

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16. The rank of the augmented matrix of the system $x - y - 2z = 6$, $-3x + 2y - 2z = -1$ and $x + 6z = -6$ is

A. 1 **B.** 4 **C.** 3 **D.** 2

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17. For the system $x - y = 8$, $-5x + y - 6z = -5$ and $-3x + y - 3z = 0$, the pair $(\text{rank}(A), \text{rank}[A \mid B])$ is

A. $(2, 3)$ **B.** $(1, 2)$ **C.** $(3, 3)$ **D.** $(2, 2)$

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18. For the system $-2z = -6$, $-2x + 4y + z = -1$ and $3x - 2y + z = 5$, the determinant Δ_2 used in Cramer's rule is

A. 0 **B.** 16 **C.** 48 **D.** -16

19. For the system $-2x - 3y - z = -11$, $2y + 2z = 6$ and $4x + 3y - 2z = 14$, the determinant Δ_2 used in Cramer's rule is

A. 16 **B.** -4 **C.** 0 **D.** -16

20. The matrix of reflection in the origin is

A. $\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$ **B.** $\begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}$

C. $\begin{bmatrix} 0 & -1 \\ -1 & 0 \end{bmatrix}$ **D.** $\begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}$

21. The image of $(3, 7)$ under reflection in the line $y = x$ is

A. $(-3, 7)$ **B.** $(3, -7)$ **C.** $(7, 3)$ **D.** $(-7, -3)$

22. For reflection in the line $y = \frac{1}{5}x$, the entry $\cos 2\theta$ of the reflection matrix is

A. $-\frac{5}{13}$ **B.** $-\frac{12}{13}$ **C.** $\frac{12}{13}$ **D.** $\frac{5}{13}$

23. The image of $(-9, 10)$ under reflection in the line $y = \sqrt{3}x$ is

A. $(\frac{9}{2} - 5\sqrt{3}, -\frac{9\sqrt{3}}{2} - 5)$ **B.** $(5 - \frac{9\sqrt{3}}{2}, \frac{9}{2} + 5\sqrt{3})$

C. $(-5\sqrt{3} - \frac{9}{2}, -5 + \frac{9\sqrt{3}}{2})$ **D.** $(\frac{9}{2} + 5\sqrt{3}, 5 - \frac{9\sqrt{3}}{2})$

24. When $(5, 7)$ is rotated anticlockwise about the origin through $135°$, its image is

A. $(\sqrt{2}, -6\sqrt{2})$ **B.** $(-6\sqrt{2}, -\sqrt{2})$

C. $(6\sqrt{2}, \sqrt{2})$ **D.** $(-\sqrt{2}, -6\sqrt{2})$

25. When $(-2, 7)$ is rotated anticlockwise about the origin through $90°$, its image is

A. $(-7, 2)$ **B.** $(-7, -2)$ **C.** $(7, 2)$ **D.** $(-2, -7)$

Key sheet

1. B	**2.** C	**3.** A	**4.** B	**5.** A
6. D	**7.** C	**8.** D	**9.** D	**10.** C
11. A	**12.** A	**13.** D	**14.** B	**15.** D
16. C	**17.** A	**18.** D	**19.** A	**20.** B
21. C	**22.** C	**23.** D	**24.** B	**25.** B

Solutions

1. For $A = \begin{bmatrix} 0 & -3 & -4 \\ 5 & 0 & 2 \\ 2 & 4 & 1 \end{bmatrix}$, the determinant of the submatrix obtained by deleting row 1 and column 3 is

Deleting row 1 and column 3 leaves $\begin{bmatrix} 5 & 0 \\ 2 & 4 \end{bmatrix}$.

$\det = (5)(4) - (0)(2) = 20$

Ans: (B) 20

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2. The rank of $\begin{bmatrix} 1 & -2 & 0 \\ -1 & 2 & 0 \\ 2 & -4 & 0 \end{bmatrix}$ is

$|A| = 0$

All rows are multiples of one row, so every 2×2 minor is 0: rank 1.

Ans: (C) 1

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3. The rank of the echelon matrix $\begin{bmatrix} 3 & 7 & 6 & -3 & -4 \\ 0 & 0 & 0 & 4 & -2 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$ is

The matrix is in echelon form, so its rank is the number of non-zero rows.

$\text{rank} = 2$

Ans: (A) 2

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4. The rank of the echelon matrix $\begin{bmatrix} 0 & 4 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ is

The matrix is in echelon form, so its rank is the number of non-zero rows.

$\text{rank} = 1$

Ans: (B) 1

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5. Using elementary transformations, the rank of $\begin{bmatrix} 1 & 0 & 4 & 3 \\ -1 & 0 & -4 & -3 \\ 2 & 0 & 8 & 6 \end{bmatrix}$ is found to be

Apply $R_2 \to R_2 + R_1$, $R_3 \to R_3 - 2R_1$: $A \sim \begin{bmatrix} 1 & 0 & 4 & 3 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$

Number of non-zero rows $= 1$, so the rank is 1.

Ans: (A) 1

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6. Using elementary transformations, the rank of $\begin{bmatrix} 1 & 1 & -1 & -2 \\ 6 & 8 & 4 & -10 \\ -2 & -3 & -3 & 3 \end{bmatrix}$ is found to be

Apply $R_2 \to R_2 - 6R_1$, $R_3 \to R_3 + 2R_1$: $A \sim \begin{bmatrix} 1 & 1 & -1 & -2 \\ 0 & 2 & 10 & 2 \\ 0 & -1 & -5 & -1 \end{bmatrix}$

Apply $R_2 \leftrightarrow R_3$: $\sim \begin{bmatrix} 1 & 1 & -1 & -2 \\ 0 & -1 & -5 & -1 \\ 0 & 2 & 10 & 2 \end{bmatrix}$

Apply $R_3 \to R_3 + 2R_2$: $\sim \begin{bmatrix} 1 & 1 & -1 & -2 \\ 0 & -1 & -5 & -1 \\ 0 & 0 & 0 & 0 \end{bmatrix}$

Number of non-zero rows $= 2$, so the rank is 2.

Ans: (D) 2

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7. A and B are square matrices of order 6 with $\text{rank}(A) = 1$ and $\text{rank}(B) = 3$. The greatest possible value of $\text{rank}(A + B)$ is

$\text{rank}(A + B) \le \text{rank}(A) + \text{rank}(B)$.

$1 + 3 = 4$

Ans: (C) 4

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8. The rank of the 5×4 null matrix is

The rank of a null matrix is defined to be 0.

Ans: (D) 0

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9. The augmented matrix of the system $4x - 4y + 6z = -4$, $-3y - z = 4$ and $-3x = 11$ is

Write the coefficients of x, y, z in order (a missing variable has coefficient 0), then the constant.

$[A \,|\, B] = \left[\begin{array}{ccc|c} 4 & -4 & 6 & -4 \\ 0 & -3 & -1 & 4 \\ -3 & 0 & 0 & 11 \end{array}\right]$

Ans: (D) $\left[\begin{array}{ccc|c} 4 & -4 & 6 & -4 \\ 0 & -3 & -1 & 4 \\ -3 & 0 & 0 & 11 \end{array}\right]$

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10. The system $-5x - 4y = -32$ and $7x + 7y = 49$ has

$\frac{a_1}{a_2} = \frac{-5}{7}$, $\frac{b_1}{b_2} = \frac{-4}{7}$, $\frac{c_1}{c_2} = \frac{-32}{49}$

$\frac{a_1}{a_2} \neq \frac{b_1}{b_2}$: the lines meet in one point.

Ans: (C) a unique solution

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11. The system $5x + 4y = -4$ and $15x + 12y = -12$ has

$\frac{a_1}{a_2} = \frac{5}{15}$, $\frac{b_1}{b_2} = \frac{4}{12}$, $\frac{c_1}{c_2} = \frac{-4}{-12}$

$\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$: the lines coincide.

Ans: (A) infinitely many solutions

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12. The system $4x + 7y = 0$, $20x + ky = 0$ has non-trivial solutions when $k =$

$\frac{4}{20} = \frac{7}{k}$

$k = 35$

Ans: (A) 35

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13. The system $8x - y = 0$, $48x + ky = 0$ has non-trivial solutions when $k =$

$\frac{8}{48} = \frac{-1}{k}$

$k = -6$

Ans: (D) -6

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14. The system $5x + ky + 3z = 0$, $-4x - 6y - 3z = 0$ and $-5x - 3y + 3z = 0$ has a non-trivial solution when $k =$

Non-trivial solutions need $|A| = 0$: $27k - 189 = 0$

$k = 7$

Ans: (B) 7

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15. The system $-5x - 4y + 3z = 0$, $-3x + 6y - z = 0$ and $kx - 2y + z = 0$ has a non-trivial solution when $k =$

Non-trivial solutions need $|A| = 0$: $-14k - 14 = 0$

$k = -1$

Ans: (D) -1

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16. The rank of the augmented matrix of the system $x - y - 2z = 6$, $-3x + 2y - 2z = -1$ and $x + 6z = -6$ is

Apply $R_3 \to R_3 + R_2$: $\sim \left[\begin{array}{ccc|c} 1 & -1 & -2 & 6 \\ 0 & -1 & -8 & 17 \\ 0 & 0 & 0 & 5 \end{array}\right]$

Non-zero rows: 3.

Ans: (C) 3

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17. For the system $x - y = 8$, $-5x + y - 6z = -5$ and $-3x + y - 3z = 0$, the pair $(\text{rank}(A), \text{rank}[A \mid B])$ is

Apply $R_3 \to R_3 - 2R_2$: $\sim \left[\begin{array}{ccc|c} 1 & -1 & 0 & 8 \\ 0 & -2 & -3 & 24 \\ 0 & 0 & 0 & -13 \end{array}\right]$

Coefficient part: 2 non-zero rows; whole matrix: 3.

Ans: (A) $(2, 3)$

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18. For the system $-2z = -6$, $-2x + 4y + z = -1$ and $3x - 2y + z = 5$, the determinant Δ_2 used in Cramer's rule is

Replace column 2 of A by the constants: $\Delta_2 = \begin{vmatrix} 0 & -6 & -2 \\ -2 & -1 & 1 \\ 3 & 5 & 1 \end{vmatrix}$

$= 0(-1 - 5) + 6(-2 - 3) - 2(-10 + 3) = -16$

Ans: (D) -16

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19. For the system $-2x-3y-z=-11$, $2y+2z=6$ and $4x+3y-2z=14$, the determinant Δ_2 used in Cramer's rule is

Replace column 2 of A by the constants: $\Delta_2 = \begin{vmatrix} -2 & -11 & -1 \\ 0 & 6 & 2 \\ 4 & 14 & -2 \end{vmatrix}$

$= -2(-12-28) + 11(0-8) - (0-24) = 16$

Ans: (A) 16

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20. The matrix of reflection in the origin is

Reflection in the origin sends $(x, y) \mapsto (-x, -y)$, so the matrix is $\begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}$.

Ans: (B) $\begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}$

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21. The image of $(3, 7)$ under reflection in the line $y = x$ is

$\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} 3 \\ 7 \end{bmatrix} = \begin{bmatrix} 7 \\ 3 \end{bmatrix}$

Ans: (C) $(7, 3)$

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22. For reflection in the line $y = \frac{1}{5}x$, the entry $\cos 2\theta$ of the reflection matrix is

$\cos 2\theta = \frac{1-\tan^2\theta}{1+\tan^2\theta} = \frac{1-(\frac{1}{5})^2}{1+(\frac{1}{5})^2} = \frac{12}{13}$

Ans: (C) $\frac{12}{13}$

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23. The image of $(-9, 10)$ under reflection in the line $y = \sqrt{3}x$ is

Reflection matrix $\begin{bmatrix} -\frac{1}{2} & \frac{\sqrt{3}}{2} \\ \frac{\sqrt{3}}{2} & \frac{1}{2} \end{bmatrix}$

Image $(\frac{9}{2} + 5\sqrt{3}, 5 - \frac{9\sqrt{3}}{2})$

Ans: (D) $(\frac{9}{2} + 5\sqrt{3}, 5 - \frac{9\sqrt{3}}{2})$

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24. When $(5, 7)$ is rotated anticlockwise about the origin through $135°$, its image is

$\begin{bmatrix} -\frac{\sqrt{2}}{2} & -\frac{\sqrt{2}}{2} \\ \frac{\sqrt{2}}{2} & -\frac{\sqrt{2}}{2} \end{bmatrix} \begin{bmatrix} 5 \\ 7 \end{bmatrix} = \begin{bmatrix} -6\sqrt{2} \\ -\sqrt{2} \end{bmatrix}$

Ans: (B) $(-6\sqrt{2}, -\sqrt{2})$

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25. When $(-2, 7)$ is rotated anticlockwise about the origin through $90°$, its image is

$\begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} -2 \\ 7 \end{bmatrix} = \begin{bmatrix} -7 \\ -2 \end{bmatrix}$

Ans: (B) $(-7, -2)$
