EXPRESSWALA ACADEMY

Maths 1A: Linear Equations

MCQ Test, Set 05

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. If the matrix $\begin{bmatrix} 6 & -1 \\ 6 & k \end{bmatrix}$ has rank 1, then $k =$

A. 1 **B.** -36 **C.** 5 **D.** -1

2. For $A = \begin{bmatrix} 1 & 5 & -3 \\ 3 & -2 & 3 \\ 5 & 3 & 6 \end{bmatrix}$, the determinant of the submatrix obtained by deleting row 3 and column 1 is

A. -21 **B.** -9 **C.** 9 **D.** 21

3. The rank of the echelon matrix $\begin{bmatrix} -3 & 6 & 0 \\ 0 & 5 & -2 \\ 0 & 0 & 6 \\ 0 & 0 & 0 \end{bmatrix}$ is

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

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

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

5. Using elementary transformations, the rank of $\begin{bmatrix} 1 & -3 & -3 & 4 \\ -5 & -1 & -3 & -10 \\ 2 & 2 & 3 & 3 \end{bmatrix}$ is found to be

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

6. Using elementary transformations, the rank of $\begin{bmatrix} 1 & 3 & 4 & 0 \\ 4 & 0 & -3 & -2 \\ -10 & -6 & -2 & 4 \end{bmatrix}$ is found to be

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

7. The rank of the identity matrix I_2 is

A. 4 **B.** 1 **C.** 0 **D.** 2

8. The rank of the 5×6 null matrix is

A. 0 **B.** 30 **C.** 5 **D.** 1

9. The system with coefficient matrix $\begin{bmatrix} -3 & -3 & 6 \\ 2 & 0 & -2 \\ -4 & -5 & 6 \end{bmatrix}$ and constant matrix $\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$ is

A. non-homogeneous **B.** homogeneous

C. inconsistent **D.** always without a solution

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10. The system $-3x + 6y = 9$ and $3x + 4y = 1$ has

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

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

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11. The solution of $-x + 5y = 16$ and $7x + 3y = 2$ is

A. $x = 1,\ y = 3$ **B.** $x = 3,\ y = -1$ **C.** $x = -1,\ y = 3$ **D.** $x = -1,\ y = -3$

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12. The homogeneous system $-x - 4y = 0$, $-3x - 4y = 0$ has

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

C. exactly one non-zero solution **D.** only the trivial solution

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13. The system $2x - y = 0$, $6x + ky = 0$ has non-trivial solutions when $k =$

A. -3 **B.** -1 **C.** 3 **D.** $-\frac{1}{3}$

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

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

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

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

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16. The rank of the augmented matrix of the system $x + 3y - 3z = 8$, $3x + 2y + 2z = 6$ and $-x - 2y - z = -3$ is

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

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17. For the system $x + 2y + z = 3$, $2y - 2z = -5$ and $x + y + 2z = 0$, the pair $(\text{rank}(A), \text{rank}[A \mid B])$ is

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

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18. For the system $2x + 4y - 2z = 6$, $-2x - 3y + 2z = -3$ and $3x + 2y - z = 1$, the determinant Δ_3 used in Cramer's rule is

A. -4 **B.** 8 **C.** 12 **D.** -8

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19. For the system $x - 2y - 2z = 13$, $3x - 2z = 9$ and $-x - 2y + 2z = -1$, the value of Δ in Cramer's rule is

A. 16 **B.** 17 **C.** -16 **D.** -48

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20. The image of $(-7, -4)$ under reflection in the line $y = x$ is

A. $(7, 4)$ **B.** $(-4, -7)$ **C.** $(4, 7)$ **D.** $(7, -4)$

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21. The image of $(3, -9)$ under reflection in the line $y = x$ is

A. $(-9, 3)$ **B.** $(3, 9)$ **C.** $(-3, -9)$ **D.** $(-3, 9)$

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22. The image of $(9, 4)$ under reflection in the line $y = \sqrt{3}x$ is

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

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

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23. The image of $(4, 2)$ under reflection in the line $y = \frac{3}{4}x$ is

A. $(-\frac{4}{5}, \frac{22}{5})$ **B.** $(-\frac{76}{25}, -\frac{82}{25})$

C. $(\frac{76}{25}, \frac{82}{25})$ **D.** $(\frac{82}{25}, \frac{76}{25})$

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24. The matrix that rotates every point anticlockwise about the origin through 150° is

A. $\begin{bmatrix} \frac{\sqrt{3}}{2} & \frac{1}{2} \\ -\frac{1}{2} & \frac{\sqrt{3}}{2} \end{bmatrix}$

B. $\begin{bmatrix} -\frac{\sqrt{3}}{2} & -\frac{1}{2} \\ \frac{1}{2} & -\frac{\sqrt{3}}{2} \end{bmatrix}$

C. $\begin{bmatrix} -\frac{\sqrt{3}}{2} & \frac{1}{2} \\ -\frac{1}{2} & -\frac{\sqrt{3}}{2} \end{bmatrix}$

D. $\begin{bmatrix} \frac{1}{2} & -\frac{\sqrt{3}}{2} \\ -\frac{\sqrt{3}}{2} & -\frac{1}{2} \end{bmatrix}$

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25. The matrix that rotates every point anticlockwise about the origin through 300° is

A. $\begin{bmatrix} -\frac{\sqrt{3}}{2} & \frac{1}{2} \\ \frac{1}{2} & \frac{\sqrt{3}}{2} \end{bmatrix}$

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

Key sheet

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

Solutions

1. If the matrix $\begin{bmatrix} 6 & -1 \\ 6 & k \end{bmatrix}$ has rank 1, then $k =$

Rank 1 means the matrix is singular: $6k - (-1)(6) = 0$

$k = -1$

Ans: (D) -1

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2. For $A = \begin{bmatrix} 1 & 5 & -3 \\ 3 & -2 & 3 \\ 5 & 3 & 6 \end{bmatrix}$, the determinant of the submatrix obtained by deleting row 3 and column 1 is

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

$\det = (5)(3) - (-3)(-2) = 9$

Ans: (C) 9

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3. The rank of the echelon matrix $\begin{bmatrix} -3 & 6 & 0 \\ 0 & 5 & -2 \\ 0 & 0 & 6 \\ 0 & 0 & 0 \end{bmatrix}$ is

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

$\text{rank} = 3$

Ans: (D) 3

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

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

$\text{rank} = 1$

Ans: (A) 1

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5. Using elementary transformations, the rank of $\begin{bmatrix} 1 & -3 & -3 & 4 \\ -5 & -1 & -3 & -10 \\ 2 & 2 & 3 & 3 \end{bmatrix}$ is found to be

Apply $R_2 \to R_2 + 5R_1$, $R_3 \to R_3 - 2R_1$: $A \sim \begin{bmatrix} 1 & -3 & -3 & 4 \\ 0 & -16 & -18 & 10 \\ 0 & 8 & 9 & -5 \end{bmatrix}$

Apply $R_2 \leftrightarrow R_3$: $\sim \begin{bmatrix} 1 & -3 & -3 & 4 \\ 0 & 8 & 9 & -5 \\ 0 & -16 & -18 & 10 \end{bmatrix}$

Apply $R_3 \to R_3 + 2R_2$: $\sim \begin{bmatrix} 1 & -3 & -3 & 4 \\ 0 & 8 & 9 & -5 \\ 0 & 0 & 0 & 0 \end{bmatrix}$

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

Ans: (B) 2

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6. Using elementary transformations, the rank of $\begin{bmatrix} 1 & 3 & 4 & 0 \\ 4 & 0 & -3 & -2 \\ -10 & -6 & -2 & 4 \end{bmatrix}$ is found to be

Apply $R_2 \to R_2 - 4R_1$, $R_3 \to R_3 + 10R_1$: $A \sim \begin{bmatrix} 1 & 3 & 4 & 0 \\ 0 & -12 & -19 & -2 \\ 0 & 24 & 38 & 4 \end{bmatrix}$

Apply $R_3 \to R_3 + 2R_2$: $\sim \begin{bmatrix} 1 & 3 & 4 & 0 \\ 0 & -12 & -19 & -2 \\ 0 & 0 & 0 & 0 \end{bmatrix}$

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

Ans: (B) 2

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7. The rank of the identity matrix I_2 is

I_2 is in echelon form with 2 non-zero rows.

$\text{rank}(I_2) = 2$

Ans: (D) 2

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8. The rank of the 5×6 null matrix is

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

Ans: (A) 0

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9. The system with coefficient matrix $\begin{bmatrix} -3 & -3 & 6 \\ 2 & 0 & -2 \\ -4 & -5 & 6 \end{bmatrix}$ and constant matrix $\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$ is

A system is homogeneous when every constant is zero, that is $B = O$.

Here $B = O$, so the system is homogeneous.

Ans: (B) homogeneous

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10. The system $-3x + 6y = 9$ and $3x + 4y = 1$ has

$\frac{a_1}{a_2} = \frac{-3}{3}$, $\frac{b_1}{b_2} = \frac{6}{4}$, $\frac{c_1}{c_2} = \frac{9}{1}$

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

Ans: (D) a unique solution

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11. The solution of $-x + 5y = 16$ and $7x + 3y = 2$ is

Eliminate one variable and substitute back.

$x = -1,\ y = 3$

Ans: (C) $x = -1,\ y = 3$

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12. The homogeneous system $-x - 4y = 0$, $-3x - 4y = 0$ has

$|A| = -8$

$|A| \neq 0$, so only $x = y = 0$.

Ans: (D) only the trivial solution

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13. The system $2x - y = 0$, $6x + ky = 0$ has non-trivial solutions when $k =$

$\frac{2}{6} = \frac{-1}{k}$

$k = -3$

Ans: (A) -3

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

Non-trivial solutions need $|A| = 0$: $12k + 24 = 0$

$k = -2$

Ans: (D) -2

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

Non-trivial solutions need $|A| = 0$: $-9k - 18 = 0$

$k = -2$

Ans: (A) -2

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16. The rank of the augmented matrix of the system $x + 3y - 3z = 8$, $3x + 2y + 2z = 6$ and $-x - 2y - z = -3$ is

Apply $R_3 \to R_3 + 7R_2$: $\sim \left[\begin{array}{ccc|c} 1 & 3 & -3 & 8 \\ 0 & 1 & -4 & 5 \\ 0 & 0 & -17 & 17 \end{array}\right]$

Non-zero rows: 3.

Ans: (C) 3

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17. For the system $x + 2y + z = 3$, $2y - 2z = -5$ and $x + y + 2z = 0$, the pair $(\text{rank}(A), \text{rank}[A \mid B])$ is

Apply $R_3 \to R_3 + 2R_2$: $\sim \left[\begin{array}{ccc|c} 1 & 2 & 1 & 3 \\ 0 & -1 & 1 & -3 \\ 0 & 0 & 0 & -11 \end{array}\right]$

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

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

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18. For the system $2x + 4y - 2z = 6$, $-2x - 3y + 2z = -3$ and $3x + 2y - z = 1$, the determinant Δ_3 used in Cramer's rule is

Replace column 3 of A by the constants: $\Delta_3 = \begin{vmatrix} 2 & 4 & 6 \\ -2 & -3 & -3 \\ 3 & 2 & 1 \end{vmatrix}$

$= 2(-3 + 6) - 4(-2 + 9) + 6(-4 + 9) = 8$

Ans: (B) 8

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19. For the system $x - 2y - 2z = 13$, $3x - 2z = 9$ and $-x - 2y + 2z = -1$, the value of Δ in Cramer's rule is

$\Delta = (0 - 4) + 2(6 - 2) - 2(-6 - 0) = 16$

Ans: (A) 16

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20. The image of $(-7, -4)$ under reflection in the line $y = x$ is

$$\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} -7 \\ -4 \end{bmatrix} = \begin{bmatrix} -4 \\ -7 \end{bmatrix}$$

Ans: (B) $(-4, -7)$

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21. The image of $(3, -9)$ under reflection in the line $y = x$ is

$$\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} 3 \\ -9 \end{bmatrix} = \begin{bmatrix} -9 \\ 3 \end{bmatrix}$$

Ans: (A) $(-9, 3)$

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22. The image of $(9, 4)$ 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 $(-\frac{9}{2} + 2\sqrt{3}, 2 + \frac{9\sqrt{3}}{2})$

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

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23. The image of $(4, 2)$ under reflection in the line $y = \frac{3}{4}x$ is

Reflection matrix $\begin{bmatrix} \frac{7}{25} & \frac{24}{25} \\ \frac{24}{25} & -\frac{7}{25} \end{bmatrix}$

Image $(\frac{76}{25}, \frac{82}{25})$

Ans: (C) $(\frac{76}{25}, \frac{82}{25})$

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24. The matrix that rotates every point anticlockwise about the origin through 150° is

$$\begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix} = \begin{bmatrix} -\frac{\sqrt{3}}{2} & -\frac{1}{2} \\ \frac{1}{2} & -\frac{\sqrt{3}}{2} \end{bmatrix}$$

Ans: (B) $\begin{bmatrix} -\frac{\sqrt{3}}{2} & -\frac{1}{2} \\ \frac{1}{2} & -\frac{\sqrt{3}}{2} \end{bmatrix}$

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25. The matrix that rotates every point anticlockwise about the origin through 300° is

$$\begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix} = \begin{bmatrix} \frac{1}{2} & \frac{\sqrt{3}}{2} \\ -\frac{\sqrt{3}}{2} & \frac{1}{2} \end{bmatrix}$$

Ans: (C) $\begin{bmatrix} \frac{1}{2} & \frac{\sqrt{3}}{2} \\ -\frac{\sqrt{3}}{2} & \frac{1}{2} \end{bmatrix}$
