MATHS

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APPLICATIONS OF MATRICES AND DETERMINANTS

Worked Example

1. If $A = \begin{bmatrix} 1 & 1 & 2 \\ 1 & 2 & 2 \\ 2 & 2 & 1 \end{bmatrix}$ verify that $A(adjA) = (adjA)A = |A|I_3$.

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2. If $A = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}$ is non - singular, find A^{-1}.

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3. Find the inverse of the matrix $\begin{bmatrix} 2 & 1 & 2 \\ 2 & 2 & 1 \\ 1 & 0 & 2 \end{bmatrix}$

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4. If A is a non - singular matrix of odd order, prove that |adj A| is positive.

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5. Find a Matrix A if adj $A = \begin{bmatrix} +7 & +9 & -10 \\ +12 & +15 & -17 \\ -1 & -1 & +1 \end{bmatrix}$

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6. If adj $A = \begin{bmatrix} 4 & -2 & -3 \\ -3 & 2 & 2 \\ -2 & 1 & 2 \end{bmatrix}$, find A^{-1}.

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7. If A is symmetric, prove that adj A is also symmetric.

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8. If $A = \begin{bmatrix} 3 & 5 \\ 2 & 1 \end{bmatrix}$ Show that $(A^T)^{-1} = (A^{-1})^T$.

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9. If $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}, B = \begin{bmatrix} 1 & 2 \\ 2 & 1 \end{bmatrix}$. Show that $(AB)^{-1} = B^{-1}A^{-1}$

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10. If $A = \begin{bmatrix} 2 & 1 \\ 3 & 0 \end{bmatrix}$ find a and b such that $A^2 + aA + bI_2 = 0$ Hence, find A^{-1}.

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11. By matrix multiplication from that $M = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}$ is orthogonal.

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12. If $A = \frac{1}{9}\begin{bmatrix} -8 & 1 & a \\ 4 & 4 & 7 \\ b & -8 & 4 \end{bmatrix}$ is orthogonal find a, b hence find A^{-1}.

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13. Reduce the matrix $\begin{bmatrix} 4 & -2 & 3 \\ -8 & 3 & 1 \\ -4 & 2 & -1 \end{bmatrix}$ to row - Echelon form.

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14. Reduce the matrix $\begin{bmatrix} 0 & 1 & 4 & 5 \\ -2 & 3 & 1 & -4 \\ 3 & 1 & -1 & 2 \end{bmatrix}$ to row echelon form.

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15. Find the rank of each of the following matrix

$$\begin{bmatrix} 2 & 1 & 3 \\ 4 & -1 & 3 \\ 1 & 4 & 5 \end{bmatrix}$$

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16. Find the rank of each of the following matrix

$$\begin{bmatrix} 2 & -1 & 1 & 2 \\ 5 & -2 & 3 & 6 \\ -3 & 1 & -2 & -4 \end{bmatrix}$$

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17. Find the rank of the following matrices which are in row - echelon form.

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

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18. Find the rank of the following matrices which are in row - echelon form.

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

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19. Find the rank of the following matrices which are in row - echelon form.

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

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20. Find the rank of the matrix

$\begin{bmatrix} 1 & -1 & 2 \\ 3 & 1 & -2 \\ 2 & 2 & 1 \end{bmatrix}$ by reducing it to a row - echelon matrix.

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21. Find the rank of the matrix

$\begin{bmatrix} 2 & 1 & 1 \\ -1 & 2 & -3 \\ 4 & 2 & 2 \end{bmatrix}$ by reducing it to a row - echelon matrix.

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22. Find the rank of the matrix $\begin{bmatrix} 1 & 2 & 2 & 1 \\ 2 & 1 & 2 & 1 \\ 2 & 2 & 1 & -1 \end{bmatrix}$ by reducing to an echelon from :

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23. Reduce the matrix $\begin{bmatrix} 2 & 0 & 3 \\ 1 & -1 & -2 \\ 4 & 1 & 0 \end{bmatrix}$ to the identity matrix by elementary row transformation, show also it is non singular.

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24. Find the inverse of the matrix $A = \begin{bmatrix} 1 & 3 \\ 2 & 5 \end{bmatrix}$ by Gauss Jordan Method.

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25. Find the inverse of $A = \begin{bmatrix} 2 & 1 & 1 \\ 3 & 2 & 1 \\ 2 & 1 & 2 \end{bmatrix}$ by Gauss - Jordan method.

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26. Solve :

$3x + 2y = 5$

$7x - y = 6,$

using matrix inversion method.

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27. Solve the following system of equation, Using matrix inversion method.

$x + 2y + z = 5$

$2x + y - z = 1$

$3x - 2y + z = 3$

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28. If $A = \begin{bmatrix} -3 & -5 & 1 \\ -3 & 3 & -3 \\ 3 & 1 & -5 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 2 & -1 \\ 2 & -1 & 1 \\ 1 & 1 & 2 \end{bmatrix}$ find the products AB and BA and hence solve the system of equation.

$x + 2y - z = 6$

$2x - y + z = 5$

$x + y + 2z = 7$

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29. Solve, by cramer's reule.

$3x - 2y = 4$

$4x + y = 9$

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30. Solve

$x + y + z = 2$

$2x + y - z = 6$

$3x + 2y + 2z = 6$

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31. A bag contain 3 types of coins namely of Rs. 1, Rs. 2 and Rs. 5. There are 30 coins amountly to Rs. 100 in total. Find the possible solution (i.e., no. of of coins in each category).

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32. Solve the following system of equation by Gaussian elimination method.

$2x - y + 3z = 3$

$4x + 2y - z = 7$

$x + 3y + 2z = 9$

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33. In the curve $y = ax^2 + bx + c$ is is observed that points $(1, 3)(-2, 3)$ and $(3, 18)$ lie on it. Find a, b and c. Hence find y when $x = -3$.

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34. Test the consistency of the system of of linear equations and if possible solve.

$x + 2y + 3z = 2, 2x + 3y - z = -2$

, x-y+z=3`

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35. Test the consistency of the linear equations $3x - y + z = 3, 2x + 2y - 3z = 1$ and $25x + 5y - 10z = 20.$

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36. Test the consistency of the following system of equation. Find the solution also.

$x - 2y + 3z = 9$

$2x - 4y + 6z = 18$

$3x - 6y + 9z = 27$

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37. Test the consistency of the following system of equation

$x + 2y - z = 2$

$2x + y + z = 4$

$3x + y + 2z = 5$

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38. Find the condition on a, b and c so that the following system of linear equation has one parametric family of solutions.

$2x + y + z = a$

$x + 3y - 2z = b$

$9x + 12y - 3z = c$

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39. Find for what values of a and b the system of linear equation.

$x + 2y + 2z = 5, 2x + 5y + 3z = 10$ and $3x + y + \lambda z = \mu$ has

(i) no solution, (ii) a unique solution, (iii) an infinite no of solution.

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40. Solve

$x + 2y + 3z = 0$

$3x + 4y + 4z = 0$

$7x + 10y + 12z = 0$

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41. Solve the system

$x + 3y - 4z = 0$

$3x - y + 2z = 0$

$4x + 2y - 2z = 0$

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42. Solve the system.

$x + 2y - z = 0, 3x - y + 2z = 0, 2x + y + z = 0$

$x - 2y - 2z = 0$

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43. Determine the value of k for which the system of equation.

$kx + 3y + 3z = 0$

$3x + ky + 3z = 0$

$3x + 3y + kz = 0$

has a non trivial solutions. $(k \in z)$.

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44. Using Gaussian elimination method, balance the chemical reaction equation.

$C_3H_4 + O \rightarrow H_2O_2 + CO_3$

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45. If the system of equation

$(b + c)x + ay + a^2z = 0,$

$(c + a)x + by + b^2z = 0,$

$(a + b)x + cy + c^2z = 0$

has a non trivial solution and $a \neq b \neq c$ prove that $a + b + c = 0$

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Solution To Exercise 1 1

1. Find the adjoint of the following :

$$\begin{bmatrix} -3 & 4 \\ 6 & 2 \end{bmatrix}$$

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2. Find the adjoint of the following :

$$\begin{bmatrix} 2 & 3 & 1 \\ 3 & 4 & 1 \\ 3 & 7 & 2 \end{bmatrix}$$

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3. Find the adjoint of the following :

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

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4. Find the inverse (if it exists) of the following

$$\begin{bmatrix} -2 & 4 \\ 1 & -3 \end{bmatrix}$$

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5. Find the inverse (if it exists) of the following

$$\begin{bmatrix} 5 & 1 & 1 \\ 1 & 5 & 1 \\ 1 & 1 & 5 \end{bmatrix}$$

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6. Find the inverse (if it exists) of the following

$$\begin{bmatrix} 2 & 3 & 1 \\ 3 & 4 & 1 \\ 3 & 7 & 2 \end{bmatrix}$$

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7. If $F(\alpha) = \begin{bmatrix} \cos\alpha & 0 & \sin\alpha \\ 0 & 1 & 0 \\ -\sin\alpha & 0 & \cos\alpha \end{bmatrix}$, show that $\left[F(\alpha\right]^{-1} = F(-\alpha)$.

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8. If $A = \begin{bmatrix} 5 & 3 \\ -1 & -2 \end{bmatrix}$, show that $A^2 - 3A - 7I_2 = O_2$ Hence find A^{-1}.

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9. If A=$\frac{1}{9}\begin{bmatrix}-8 & 1 & 4 \\ 4 & 4 & 7 \\ 1 & -8 & 4\end{bmatrix}$, prove that $A^{-1}=A^T$.

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10. If A=$\begin{bmatrix}8 & -4 \\ -5 & 3\end{bmatrix}$, verify that A(adj A)= (adj A) A= $|A|I_2$.

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11. If A = $\begin{bmatrix}3 & 2 \\ 7 & 5\end{bmatrix}$ and B $=\begin{bmatrix}-1 & -3 \\ 5 & 2\end{bmatrix}$ verify that $(AB)^{-1}=B^{-1}A^{-1}$.

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12. If adj (A) = $\begin{bmatrix}2 & -4 & 2 \\ -3 & 12 & -7 \\ -2 & 0 & 2\end{bmatrix}$, find A.

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13. If adj (A) = $\begin{bmatrix} 0 & -2 & 0 \\ 6 & 2 & -6 \\ -3 & 0 & 6 \end{bmatrix}$ find A^{-1}.

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14. Find adj (adj(A)) if adj A = $\begin{bmatrix} 1 & 0 & 1 \\ 0 & 2 & 0 \\ -1 & 0 & 1 \end{bmatrix}$.

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15. $A = \begin{bmatrix} 1 & \tan x \\ -\tan x & 1 \end{bmatrix}$, show that $A^T A^{-1} = \begin{bmatrix} \cos 2x & -\sin 2x \\ \sin 2x & \cos 2x \end{bmatrix}$.

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16. Find the matrix A for which $A\begin{bmatrix}5 & 3\\ -1 & -2\end{bmatrix}=\begin{bmatrix}14 & 7\\ 7 & 7\end{bmatrix}$.

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17. Given A = $A=\begin{bmatrix}1 & -1\\ 2 & 0\end{bmatrix}, B=\begin{bmatrix}3 & -2\\ 1 & 1\end{bmatrix} \text{and} \quad C=\begin{bmatrix}1 & 1\\ 2 & 2\end{bmatrix}$,

find a matrix X such that AXB = C.

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18. If $A=\begin{bmatrix}0 & 1 & 1\\ 1 & 0 & 1\\ 1 & 1 & 0\end{bmatrix}$, show that $A^{-1}=\frac{1}{2}\left(A^2-3I\right)$

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19. Decrypt the received encoded message [2,-3][20,4] with the encryption matrix $\begin{bmatrix}-1 & -1\\ 2 & 1\end{bmatrix}$ and the decryption matrix as its inverse, where the system of codes are described by the numbers 1-26 to the letters A-Z respectively, and the number 0 to a blank space.

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Solution To Exercise 1 2

1. Find the rank of the following matrices by minor method :

$$\begin{bmatrix} 2 & -4 \\ -1 & 2 \end{bmatrix}$$

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2. Find the rank of the following matrices by minor method :

$$\begin{bmatrix} -1 & 3 \\ 4 & -7 \\ 3 & -4 \end{bmatrix}$$

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3. Find the rank of the following matrices by minor method :

$$\begin{bmatrix} 1 & -2 & -1 & 0 \\ 3 & -6 & -3 & 1 \end{bmatrix}$$

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4. Find the rank of the following matrices by minor method :

$$\begin{bmatrix} 1 & -2 & 3 \\ 2 & 4 & -6 \\ 5 & 1 & -1 \end{bmatrix}$$

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5. Find the rank of the following matrices by minor method :

$$\begin{bmatrix} 0 & 1 & 2 & 1 \\ 0 & 2 & 4 & 3 \\ 8 & 1 & 0 & 2 \end{bmatrix}$$

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6. Find the rank of the following matrices by row reduction method.

$$\begin{bmatrix} 1 & 1 & 1 & 3 \\ 2 & -1 & 3 & 4 \\ 5 & -1 & 7 & 11 \end{bmatrix}$$

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7. Find the rank of the following matrices by row reduction method.

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

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8. Find the rank of the following matrices by row reduction method.

$$\begin{bmatrix} 3 & -8 & 5 & 2 \\ 2 & -5 & 1 & 4 \\ -1 & 2 & 3 & -2 \end{bmatrix}$$

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9. Find the inverse of $\begin{bmatrix} 2 & -1 \\ 5 & -2 \end{bmatrix}$ by Gauss Jorden method.

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10. Find the inverse of reach of the following by Gauss - Jordan method :

$$\begin{bmatrix} 1 & -1 & 0 \\ 1 & 0 & -1 \\ 6 & -2 & -3 \end{bmatrix}$$

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11. Find the inverse of each of the following by Gauss - Jordan method :

$$\begin{bmatrix} 1 & 2 & 3 \\ 2 & 5 & 3 \\ 1 & 0 & 8 \end{bmatrix}$$

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Solution To Exercise 1 3

1. Solved the following system of linear equations by matrix inversion method.

$2x + 5y = -2, x + 2y = -3$

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2. Solve the following system of linear equations by matrix inversion method.

2x-y=8,3x+2y=-2

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3. Solved the following system of linear equations by matrix inversion method.

$2x + 3y - z = 9, x + y + z = 9, 3x - y - z = -1$

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4. Solve the following system of linear equations by matrix inversion method.

x+y+z-=2 = 0, 6x-4y+5z-31=0,5x+2y+2z=13.

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5. If A= $\begin{bmatrix} -5 & 1 & 3 \\ 7 & 1 & -5 \\ 1 & -1 & 1 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 1 & 2 \\ 3 & 2 & 1 \\ 2 & 1 & 3 \end{bmatrix}$, find the products AB and BA and hence solve the system of equations x+y+2z= 1,3x+2y+z=7, 2x+y+3z=2.

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6. A man is appointed in a job with a monthly salary of certain amount and a fixed amount of annual increment. If his salary was Rs 19,800 per month at the end of the first month after 3 years of service and Rs 23,400 per month at the end of the first month after 9 years of service find his starting salary and his annual increment. (Use matrix inversion method to solve the problem.)

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7. Four men and 4 women can finish a piece of work jointly in 3 days while 2 men and 5 women can finish the same work jointly in 4 days. Find the time taken by one man alone and that of one woman alone to finish the same work by using matrix inversion method.

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8. The prices of three commodities A,B and C are Rs x, y and z per unit respectively. A person P purchases 4 units of B and sells two units of A and 5 units of C. Person Q purchases 2 units of C and sells 3 units of A and one unit of B. Person R purchases one unit of A and sells 3 unit of B and one unit of C. In the process, PQ and R earn Rs 15,000, Rs 1,000 and Rs 4,000 respectively. Find the prices per unit of A,B and C. (Use matrix inversion method to solve the problem.)

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Solution To Exercise 1 4

1. Solve the following systems of linear equation by Cramer's rule:

5x-2y+16=0,x+3y-7=0

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2. Solve the following systems of linear equation by Cramer's rule:

$$\frac{3}{x} + 2y = 12, \frac{2}{x} + 3y = 13$$

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3. Solve the following systems of linear equation by Cramer's rule:

3x+3y-z=11, 2x-y+2z=9, 4x+3y+2z=25

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4. Solve the following systems of linear equation by Cramer's rule:

$$\frac{3}{x}-\frac{4}{y}-\frac{2}{z}-1=0, \frac{1}{x}+\frac{2}{y}+\frac{1}{z}-2=0, \frac{2}{x}-\frac{5}{y}-\frac{4}{z}+1=0$$

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5. In a competitive examination, one mark is awarded for every correct answer while $\frac{1}{4}$ mark is deducted for every wrong answer. A student answered 100 questions and got 80 marks. How many questions did he answer correctly ? (Use Cramer's rule to solve the problem).

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6. A chemist has one solution which is 50% acid and another solution which is 25 % acid. How much each should be mixed to

make 10 litres of a 40 % acid solution ? (Use Cramer's rule to solve the problem).

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7. A fish tank can be filled in 10 minutes using both pumps A and B simultaneously. However, pump B can pump water in or out at the same rate. If pump B is inadvertently run in reverse, then the tank will be filled in 30 minutes. How long would it take each pump to fill the tank by itself ? (Use Cramer's rule to solve the problem).

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8. A family of 3 people went out for dinner in a restaurant. The cost of two dosai, three idlies and two vadais is Rs 150. The cost of the two dosai, two idlies and four vadais is Rs 200. The cost of five dosai, four idlies and two vadais is Rs 250. The family has Rs 350 in hand and they ate 3 dosai and six idlies and six vadais. Will they be able to manage to pay the bill within the amount they had?

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Solution To Exercise 1 5

1. Solve the following systems of linear equations by Gaussian elimination method.

$2x-2y+3z=2, x+2y-z=3, 3x-y+2z=1.$

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2. Solve the following systems of linear equations by Gaussian elimination method.

$2x+4y+6z=22, 3x+8y+5z=27, -x+y+2z=2$

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3. If ax^2+bx+c is divided by x+3,x-5, and x-1, the remainders are 21, 61 and 9 respectively. Find a,b, and c. (Use Gaussian elimination method.)

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4. An amount of Rs 65,000 is invested in three bonds at the rates of 6 % , 8% and 10% per annum respectively. The total annual income is Rs 4,800. The income from the third bond is Rs 600 more than that from the second bond. Determine the price of each bond. (Use Gaussian elimination method.)

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5. A boy is walking along the path $y = ax^2 + bx + c$ through the points (-6,8),(-2,-12), and (3,8). He wants to meet his friend at P(7,60). Will he meet his friend? (Use Gaussian elimination method.)

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Solution To Exercise 1 6

1. Test for consistency and if possible solve the following system of equations by rank method.

x-y+2z=2,2x+y+4z=7,4x-y+z=4

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2. Test for consistency and if possible solve the following system of equations by rank method.

$3x+y+z=2, x-3y+2z=1, 7x-y+4z=5.$

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3. Test for consistency and if possible solve the following system of equations by rank method.

$2x+2y+z=5, x-y+z=1, 3x+y+2z=4$

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4. Test for consistency and if possible solve the following system of equations by rank method.

$2x-y+z=2, 6x-3y+3z=6, 4x-2y+2z=4.$

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5. Find the value of k for which the equations kx-2y+z=1, x-2ky+z=-2,x-2y+kz=1 have

(i) no solution

(ii) unique solution

(iii) infinitely many solution

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6. In vestigate the values of λ and μ the system of linear equations 2x+3y+5z=9,7x+3y-5z=8, 2x+3y+λz=μ, have

(i) no solution

(ii) a unique solution

(iii) an infinite number of solutions.

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Solution To Exercise 1 7

1. Solve the following system of homogeneous equations.

3x+2y+7z=0,4x-3y-2z=0, 5x+9y+23z=0

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2. Solve the following system of homogeneous equations.

2x+3y-z=0,x-y-2z=0,3x+y+3z=0.

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3. Determine the values of λ for which the following system of equations x+y+3z=0,4x+3y+λz=0, 2x+y+2z=0 has

(i) a unique solution

(ii) a non-trivial solution.

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4. By using Gaussian elimination method, balance the chemical - reaction equation : $C_2H_6 + O_2 \rightarrow H_2O + CO_2$

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Solution To Exercise 1 8

1. If $|adj(adjA)| = |A|^9$ square matrix A is

A. 3

B. 4

C. 2

D. 5

Answer: B

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2. If A is a 3×3 non -singular matrix such that $\mathrm{AA}^T = A^T A \text{ and } B = A^{-1} A^T, \text{ then } BB^T$ =

A. A

B. B

C. I

D. B^T

Answer: C

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3. A= $\begin{bmatrix} 3 & 5 \\ 1 & 2 \end{bmatrix}$, B=adj A and C =3A, then $\frac{|adjB|}{|C|}$=

A. $\frac{1}{3}$

B. $\frac{1}{9}$

C. $\frac{1}{4}$

D. 1

Answer: A

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4. If A $\begin{bmatrix} 1 & -2 \\ 1 & 4 \end{bmatrix} = \begin{bmatrix} 6 & 0 \\ 0 & 6 \end{bmatrix}$, then A=

A. $\begin{bmatrix} 1 & -2 \\ 1 & 4 \end{bmatrix}$

B. $\begin{bmatrix} 1 & 2 \\ -1 & 4 \end{bmatrix}$

C. $\begin{bmatrix} 4 & 2 \\ -1 & 1 \end{bmatrix}$

D. $\begin{bmatrix} 4 & -1 \\ 2 & 1 \end{bmatrix}$

Answer: C

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5. If A = $\begin{bmatrix} 7 & 3 \\ 4 & 2 \end{bmatrix}$, then $9I_2 - A =$

A. A^{-1}

B. $\frac{A^{-1}}{2}$

C. $3A^{-1}$

D. $2A^{-1}$

Answer: D

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6. If A = $\begin{bmatrix} 2 & 0 \\ 1 & 5 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 4 \\ 2 & 0 \end{bmatrix}$ then |adj(AB)|=

A. -40

B. -80

C. -60

D. -20

Answer: B

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7. If P = $\begin{vmatrix} 1 & x & 0 \\ 1 & 3 & 0 \\ 2 & 4 & -2 \end{vmatrix}$ is the adjoint of 3×3 matrix A and |A|=4, then x is

A. 15

B. 12

C. 14

D. 11

Answer: D

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8. If A = $\begin{bmatrix} 3 & 1 & -1 \\ 2 & -2 & 0 \\ 1 & 2 & -1 \end{bmatrix}$ and $A^{-1} = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}$ then the value of a_{23} is

A. 0

B. -2

C. -3

D. -1

Answer: D

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9. If A, B and C are invertible matrices of some order, then which one of the following is not true?

A. $adjA = |A|A^{-1}$

B. adj (A) = (adj A)(adj B)

C. $\det A^{-1} = (\det A)^{-1}$

D. $(ABC)^{-1} = C^{-1}B^{-1}A^{-1}$

Answer: B

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10. If

$(AB)^{-1} = \begin{bmatrix} 12 & -17 \\ -19 & 27 \end{bmatrix} \text{and} A^{-1} = \begin{bmatrix} 1 & -1 \\ -2 & 3 \end{bmatrix} \text{then} \quad B^{-1}$=

A. $\begin{bmatrix} 2 & -5 \\ -3 & 8 \end{bmatrix}$

B. $\begin{bmatrix} 8 & 5 \\ 3 & 2 \end{bmatrix}$

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

D. $\begin{bmatrix} 8 & -5 \\ -3 & 2 \end{bmatrix}$

Answer: A

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11. If $A^T . A^{-1}$ is symmetric, then A^2=

A. A^{-1}

B. $(A^T)^2$

C. A^T

D. $(A^{-1})^2$

Answer: B

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12. If A is a non-singular matrix such that $A^{-1}=\begin{bmatrix}5 & 3\\ -2 & -1\end{bmatrix}$, then $\left(A^T\right)^{-1}$=

A. $\begin{bmatrix}-5 & 3\\ 2 & 1\end{bmatrix}$

B. $\begin{bmatrix}5 & 3\\ -2 & -1\end{bmatrix}$

C. $\begin{bmatrix}-1 & -3\\ 2 & 5\end{bmatrix}$

D. $\begin{bmatrix}5 & -2\\ 3 & -1\end{bmatrix}$

Answer: D

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13. A = $\begin{bmatrix} \frac{3}{5} & \frac{4}{5} \\ x & \frac{3}{5} \end{bmatrix}$ and $A^T = A^{-1}$, then the value of x is

A. $\frac{-4}{5}$

B. $\frac{-3}{5}$

C. $\frac{3}{5}$

D. $\frac{4}{5}$

Answer: A

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14. If A = $\begin{bmatrix} 1 & \tan\frac{\theta}{2} \\ -\tan\frac{\theta}{2} & 1 \end{bmatrix}$ and AB = I_2, then B=

A. $\left(\cos^2\frac{\theta}{2}\right)A$

B. $\left(\cos^2\frac{\theta}{2}\right)^{A^T}$

C. $(\cos^2\theta)I$

D. $\left(\sin^2\frac{\theta}{2}\right)A$

Answer: B

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15. If $A=\begin{bmatrix}\cos\theta & \sin\theta\\ -\sin\theta & \cos\theta\end{bmatrix}$ and $A(adjA)=\begin{bmatrix}k & 0\\ 0 & k\end{bmatrix}$, then k =

A. 0

B. $\sin\theta$

C. $\cos\theta$

D. 1

Answer: D

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16. If $A = \begin{bmatrix} 2 & 3 \\ 5 & -2 \end{bmatrix}$ be such that $\lambda A^{-1} = A$, then λ is

A. 17

B. 14

C. 19

D. 21

Answer: C

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17. If adj $A = \begin{bmatrix} 2 & 3 \\ 4 & 1 \end{bmatrix}$ and adj $B = \begin{bmatrix} 1 & -2 \\ -3 & 1 \end{bmatrix}$ then adj (AB) is :

A. $\begin{bmatrix} -7 & -1 \\ 7 & -9 \end{bmatrix}$

B. $\begin{bmatrix} -6 & 1 \\ -2 & -8 \end{bmatrix}$

C. $\begin{bmatrix} -7 & 7 \\ -1 & -9 \end{bmatrix}$

D. $\begin{bmatrix} -6 & -2 \\ 5 & -10 \end{bmatrix}$

Answer: B

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18. The rank of the matrix $\begin{bmatrix} 1 & 2 & 3 & 4 \\ 2 & 4 & 6 & 8 \\ -1 & -2 & -3 & -4 \end{bmatrix}$ is

A. 1

B. 2

C. 3

D. 4

Answer: A

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19. If

$$x^a y^b = e^m, x^c y^d = e^n, \Delta_1 = \begin{bmatrix} m & b \\ n & d \end{bmatrix} \Delta_2 = \begin{bmatrix} a & m \\ c & n \end{bmatrix}, \Delta_3 = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$$

then the value of x and y are respectively.

A. $e^{(\Delta_2 / \Delta_1)}, e^{(\Delta_3 / \Delta_1)}$

B. $\log(\Delta_1 / \Delta_3), \log(\Delta_2 / \Delta_3)$

C. $\log(\Delta_2 / \Delta_1), \log(\Delta_3 / \Delta_1)$

D. $e^{(\Delta_1 / \Delta_3)}, e^{(\Delta_2 / \Delta_3)}$

Answer: D

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20. Which of the following is/are correct ?

(i) Adjoint of a symmetric matrix is also a symmetric matrix.

(ii) Adjoint of a diagonal matrix is also a diagonal matrix.

(iii) If A is a square matrix of order n and λ is a scalar, then adj ($\lambda A) = \lambda^n$ adj(A)

(iv) A (adj A) = (adj A) A = $|A|I$

A. Only (i)

B. (ii) and (iii)

C. (iii) and (iv)

D. (i), (ii) and (iv)

Answer: D

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21. If ρ (A) = ρ ([A|B]), then the system AX = B of linear equations is

A. consistent and has a unique solution

B. conistent

C. consistent and has infinitely many solution

D. inconsistent.

Answer: B

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22. If $0 \leq \theta \leq \pi$ and the system of equations x+(sin $\theta)y-(\cos\theta)z=0, (\cos\theta)x-y+z=0, (\sin\theta)x+y-z=0$ has a non -trivial solution then θ is

A. $\frac{2\pi}{3}$

B. $\frac{3\pi}{4}$

C. $\frac{5\pi}{6}$

D. $\frac{\pi}{4}$

Answer: D

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23. The augmented matrix of a system of linear equations is $\begin{bmatrix} 1 & 2 & 7 & 3 \\ 0 & 1 & 4 & 6 \\ 0 & 0 & \lambda - 7 & \mu + 5 \end{bmatrix}$. The system has infinitely many solutions if

A. $\lambda = 7, \mu \neq -5$

B. $\lambda = -7, \mu = 5$

C. $\lambda \neq 7, \mu \neq -5$

D. $\lambda = 7, \mu = -5$

Answer: D

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24. Let A $= \begin{bmatrix} 2 & -1 & 1 \\ -1 & 2 & -1 \\ 1 & -1 & 2 \end{bmatrix} \text{and} 4B = \begin{bmatrix} 3 & 1 & -1 \\ 1 & 3 & x \\ -1 & 1 & 3 \end{bmatrix}.$

If B is the inverse of A, then the value of x is

A. 2

B. 4

C. 3

D. 1

Answer: B

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25. If A = $\begin{bmatrix} 3 & -3 & 4 \\ 2 & -3 & 4 \\ 0 & -1 & 1 \end{bmatrix}$, then adj (adj A) is

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

B. $\begin{bmatrix} 6 & -6 & 8 \\ 4 & -6 & 8 \\ 0 & -2 & 2 \end{bmatrix}$

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

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

Answer: A

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Problems For Practice I Choose The Correct Answer

1. If $\begin{bmatrix} 3 & 2 \\ 2 & -3 \end{bmatrix} = A$ is such that $kA^{-1} = A$ then K is :

A. $\frac{1}{13}$

B. 9

C. 11

D. 13

Answer: D

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2. If adj $A = \begin{bmatrix} 2 & 1 \\ 3 & -1 \end{bmatrix}$, adj $B = \begin{bmatrix} 2 & 3 \\ -1 & 2 \end{bmatrix}$ then adj (AB) is :

A. $\begin{bmatrix} -3 & -8 \\ -7 & -3 \end{bmatrix}$

B. $\begin{bmatrix} -13 & 1 \\ -4 & 3 \end{bmatrix}$

C. $\begin{bmatrix} 13 & -1 \\ 4 & -3 \end{bmatrix}$

D. $\begin{bmatrix} 3 & 8 \\ 7 & 7 \end{bmatrix}$

Answer: C

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3. The rank of the matrix $\begin{bmatrix} 2 & -1 & 2 & 4 \\ 3 & 1 & 4 & -1 \\ 5 & 0 & 6 & 3 \end{bmatrix}$ is :

A. 1

B. 2

C. 3

D. 4

Answer: B

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4. If $A = \begin{bmatrix} \frac{4}{5} & \frac{3}{5} \\ x & \frac{4}{5} \end{bmatrix}$ and $A^T = A^{-1}$ then x is :

A. $\frac{4}{5}$

B. $-\frac{3}{5}$

C. $-\frac{4}{5}$

D. $\frac{3}{5}$

Answer: B

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5. If A is a square matrix of order 4 then |adj A| is :

A. $|A|$

B. $|A|^4$

C. $|A|^9$

D. $|A|^{16}$

Answer: C

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6. If $A = \begin{bmatrix} 4 & 0 \\ 1 & 2 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 3 \\ 2 & 0 \end{bmatrix}$ then |adj AB| is :

A. 48

B. 36

C. -48

D. 64

Answer: C

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7. If $A\begin{bmatrix} 1 & -3 \\ 1 & 4 \end{bmatrix} = \begin{bmatrix} 7 & 0 \\ 0 & 7 \end{bmatrix}$ then A is :

A. $\begin{bmatrix} 4 & 3 \\ -1 & 1 \end{bmatrix}$

B. $\begin{bmatrix} 4 & 3 \\ 1 & -1 \end{bmatrix}$

C. $\begin{bmatrix} -4 & 3 \\ -1 & -1 \end{bmatrix}$

D. $\begin{bmatrix} 4 & 3 \\ 1 & 1 \end{bmatrix}$

Answer: A

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8. If $P = \begin{bmatrix} 1 & 0 & x \\ 3 & 0 & 1 \\ -1 & -2 & 4 \end{bmatrix}$ is the adjoint of (3×3) matrix A and $|A| = 4$. Then x is :

A. 2

B. 3

C. -1

D. 4

Answer: B

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9. If A is a non singular matrix such that $A^{-1}=\begin{bmatrix}7&-2\\-3&1\end{bmatrix}$ then $(A^T)^{-1}$ is :

A. $\begin{bmatrix}-7&2\\3&-1\end{bmatrix}$

B. $\begin{bmatrix}7&-3\\-2&1\end{bmatrix}$

C. $\begin{bmatrix}1&2\\3&7\end{bmatrix}$

D. $\begin{bmatrix}2&1\\7&3\end{bmatrix}$

Answer: B

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10. If $A=\begin{bmatrix}2&3\\3&5\end{bmatrix}$ and A(adj A) $=\begin{bmatrix}k&0\\0&k\end{bmatrix}$ then k is :

A. 10

B. 3

C. -1

D. 1

Answer: D

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11. If $x^2y^3 = e^5, x^3y^4 = e^7$ then y is :

A. 1

B. 2

C. e^2

D. e

Answer: D

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12. The angumented matrix of a system of linear equation is $\begin{bmatrix} 1 & 3 & -2 & 5 \\ 0 & 1 & 2 & -3 \\ 0 & 0 & \lambda-2 & \mu+1 \end{bmatrix}$ then system has no solution.

A. $\lambda = 2, \mu = -1$

B. $\mu \neq 2, \mu \neq -1$

C. $\lambda \neq 2, \mu = -1$

D. $\lambda = 2, \mu \neq -1$

Answer: D

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13. If $A = \begin{bmatrix} 3 & -1 & 0 \\ 2 & 4 & 1 \\ -2 & -3 & 5 \end{bmatrix}$ the cofactor of 1 is :

A. -11

B. 11

C. 15

D. 14

Answer: B

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14. If $A = \begin{bmatrix} 2 & 5 \\ 1 & 3 \end{bmatrix}$, $5I - A =$:

A. A^{-1}

B. 2A

C. $\frac{A^{-1}}{2}$

D. $5A^{-1}$

Answer: A

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15. If $A = \begin{bmatrix} -4 & 4 & 4 \\ -7 & 1 & 3 \\ 5 & -3 & -1 \end{bmatrix}, B = \begin{bmatrix} 1 & -1 & 1 \\ 1 & -2 & -2 \\ 2 & 1 & 3 \end{bmatrix}$ and AB = BA, then $B^{-1} = kA$ then k is :

A. $\frac{1}{2}$

B. 8

C. $\frac{1}{8}$

D. 2

Answer: C

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16. Match the following :

16.	$\|\text{adj } A\|$	(a) $\frac{\text{Adj } A}{\det A}$
17.	$\|A^{-1}\|$	(b) $B^{-1}A^{-1}$
18.	If A and B are orthogonal matrices $(AB)^T$	(c) $\frac{1}{\|A\|}$
19.	A^{-1}	(d) A
20.	$(A^{-1})^{-1}$	(e) $\|A\|^{n-1}$

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17. Find the incorrect statement in the following :

A. $\det(A^{-1}) = \det(A)^{-1}$

B. $(AB)^{-1} = B^{-1}A^{-1}$

C. adj (AB) = (adj A) (adj B)

D. $adjA = |A|A^{-1}$

Answer: C

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18. Find the incorrect statement in the following :

A. If (a_{ij}) is a square matrix of order 3 as A_{ij} is the cofactor of (a_{ij}) then $a_{21}A_{31}+a_{22}A_{32}+a_{23}A_{33}=0.$

B. The rank of the matrix $\begin{bmatrix}-2 & 1 & 3\\ -4 & 2 & 6\\ -6 & 3 & 9\end{bmatrix}$ is 1.

C. The value of the determinant $\begin{bmatrix}3 & -2 & 5\\ 21 & 45 & 79\\ 24 & 43 & 84\end{bmatrix}$ is 0.

D. If A and B are two orthogonal matrices of same order then AB is not orthogonal matrix.

Answer: D

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19. Find the correct statement :

A. If $\rho[A] = \rho[A \mid B] =$ no. of unknowns then the system has unique solution.

B. The homogeneous system of linear equations AX = 0 has a trivial solution of |A| = 0.

C. $adj(\lambda A) = \lambda(adjA)$

D. $|adj(adjA)| = |A|^{n^2}$

Answer: A

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20. Find the odd one out :

A. $\begin{bmatrix} 2 & 1 \\ 6 & 3 \end{bmatrix}$

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

C. $\begin{vmatrix} 1 & 3 & 2 \\ 2 & 6 & 4 \\ -3 & -9 & -6 \end{vmatrix}$

D. $\begin{vmatrix} 2 & 3 & 5 \\ 1 & 0 & 2 \\ 2 & -1 & 2 \end{vmatrix}$

Answer: D

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21. Find the odd one out :

If $A = \begin{vmatrix} 3 & 7 \\ 4 & 9 \end{vmatrix}$ then its inverse is :

A. $\begin{bmatrix} 9 & -7 \\ -4 & 3 \end{bmatrix}$

B. $\begin{bmatrix} -3 & 7 \\ 4 & -9 \end{bmatrix}$

C. $\begin{bmatrix} \frac{1}{3} & \frac{1}{7} \\ \frac{1}{4} & \frac{1}{9} \end{bmatrix}$

D. $\begin{bmatrix} -3 & -7 \\ -4 & -9 \end{bmatrix}$

Answer: A

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22. If A is a matrix of order (2×3) then A^{-1} will be :

A. (3×2) matrix

B. (2×2) matrix

C. (3×3) matrix

D. none of these

Answer: D

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23. Two matrices A and B equivalent. Find which is correct :

A. A and B are of the same order

B. $\rho(A) = \rho(B)$

C. A and B are of the same order and $\rho(A) = \rho(B)$

D. $|A| = |B|$

Answer: C

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24. If $A = \begin{vmatrix} 0 & 1 & a \\ 1 & a & 0 \\ a & 0 & 1 \end{vmatrix}$ is invertible matrix then $a \neq$:

A. 0

B. 1

C. -1

D. 2

Answer: C

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25. If the system $\lambda x + 2y = \mu$ and $7x + 2y = 5$ have many solution is :

A. $\lambda = 0, \mu = 1$

B. $\lambda = 1, \mu =$ any value

C. $\lambda \neq 7, \mu = 5$

D. $\lambda = 7, \mu = 5$

Answer: D

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26. The rank of $\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix}$ is :

A. 3

B. 1

C. 2

D. 0

Answer: C

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27. Find the correct statement in the following :

A. $|A+B| = |A| + |B|$

B. $(AB)^{-1} = A^{-1}B^{-1}$

C. $(AB)^T = A^T B^T$

D. $|AB| = |A||B|$

Answer: D

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28. Which of the following is not an elementary transformation ?

A. Interchanging any two rows or any two columns.

B. Interchanging rows and columns.

C. Multiplication of the elements of a row or column by a non zero constant.

D. Addition of the elements of a row, the corresponding elements of another row.

Answer: B

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29. In a system equations if $\Delta = 0$, then which of the following is true.

A. It has unique solution

B. It has either no solution or infinite solution

C. It can not be solved at all

D. It can be solved by crammer's rule

Answer: B

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30. Which one of the following is the Echelon form :

A. $\begin{bmatrix} 2 & 3 & 5 \\ 4 & 0 & -1 \\ 0 & 0 & 0 \end{bmatrix}$

B. $\begin{bmatrix} 3 & 1 & 5 \\ 2 & 4 & 0 \\ 0 & 0 & 0 \end{bmatrix}$

C. $\begin{bmatrix} 2 & 1 & 0 \\ 0 & 4 & 5 \\ 0 & 0 & 0 \end{bmatrix}$

D. $\begin{bmatrix} 2 & 3 & 0 \\ 4 & 0 & 0 \\ 0 & 2 & 0 \end{bmatrix}$

Answer: C

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31. The inverse of $A = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix}$ is :

A. A

B. $-A$

C. A^T

D. $-A^T$

Answer: C

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32. Find the correct pair from the following

(i) In a system of equations if $\Delta \neq 0, \Delta_x \neq 0, \Delta_y \neq 0, \Delta_z \neq 0$ then it has unique solution.

(ii) Interchange of rows and columns is an elementary operation.

(iii) $(AB)^{-1} = B^{-1}A^{-1}$

(iv) $(B)^T = A^T B^T$

A. (i) and (ii)

B. (i) and (iii)

C. (iii) and (iv)

D. (ii) and (iv)

Answer: B

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33. Find the odd one out :

A. $\begin{vmatrix} 1 & 3 \\ 1 & 3 \end{vmatrix}$

B. $\begin{vmatrix} -1 & 2 \\ -5 & 10 \end{vmatrix}$

C. $\begin{vmatrix} 6 & -12 \\ 7 & -14 \end{vmatrix}$

D. $\begin{vmatrix} 8 & 7 \\ 5 & 4 \end{vmatrix}$

Answer: D

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34. Find the incorrect pair of statements :

(i) Two matrices A and B of same order are equivalent if $\rho(A) = \rho(B)$

(ii) $|adjA| = |A|^{n-1}$ where n is the order of the matrix.

(iii) $A(adjA) = |A|^2 I$

(iv) If A and B are two square matrices of order 3 than AB = BA.

A. (i) and (ii)

B. (iii) and (iv)

C. (i) and (iii)

D. (ii) and (iv)

Answer: B

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35. Assertion : A matrix A is orthogonal if and only if A is non singular and $A^{-1} = A^T$

Reason : By definition A is orthogonal if $AA^T = A^T A = I$

A. Assertion can be proved using Reason

B. Assertion and Reason are true only for second order matrices.

C. Reason can be proved using Assertion

D. Both Assertion and Reason are true.

Answer: D

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Problems For Practice Ii Answer The Following

1. If $A = \begin{bmatrix} 1 & 2 & 1 \\ 1 & 1 & 2 \\ 2 & 2 & 1 \end{bmatrix}$ verify $A(adjA) = (adjA)A = |A|I_3$.

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2. Find the inverse of $A = \begin{bmatrix} 1 & 3 & 7 \\ 4 & 2 & 3 \\ 1 & 2 & 1 \end{bmatrix}$

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3. If $A = \begin{bmatrix} 3 & 1 \\ 2 & 5 \end{bmatrix} B = \begin{bmatrix} 1 & 2 \\ 2 & 3 \end{bmatrix}$ verify

$(AB)^{-1} = B^{-1}A^{-1}$

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4. If $A = \begin{bmatrix} 3 & 1 \\ 2 & 5 \end{bmatrix} B = \begin{bmatrix} 1 & 2 \\ 2 & 3 \end{bmatrix}$ verify $(AB)^T = B^T A^T$.

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5. If $A = \begin{bmatrix} 3 & 1 \\ 2 & 5 \end{bmatrix} B = \begin{bmatrix} 1 & 2 \\ 2 & 3 \end{bmatrix}$ verify $adj(AB) = (adjB)(adjA)$

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6. Show that $A = A^{-1}$ if $A \begin{bmatrix} -1 & 2 & -2 \\ 4 & -3 & 4 \\ 4 & -4 & 5 \end{bmatrix}$ Hence find A^2.

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7. Solve :

$2x - y = 7$

$3x - 2y = 11$ by

Crammer's rule

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8. Solve :

$2x - y = 7$

$3x - 2y = 11$ by

Matrix inversion method.

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9. Find the rank of the matrix $\begin{bmatrix} 1 & -2 & 3 & 4 \\ -2 & 4 & -1 & -3 \\ -1 & 2 & 7 & 6 \end{bmatrix}$

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10. Solve by Crammer's rule.

$2x + y + z = 5, x + y + z = 4, x - y + 2z = 1.$

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11. A hall has a capacity for 100 chairs. The cost of a red chair is Rs. 240, blue chair Rs. 260 and green chair Rs. 300. The total cost of chairs is Rs. 25,000. Find atleast 3 different solutions of the no. of chairs to be purchased.

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12. Solve the system :

$2x + 3y - z = 0, x + y + z = 0, 2x + y + 2z = 0.$

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13. Test the consistency of the following system of linear equation and if possible solve by Gaussian elimination method. Verify your answer after solving by Crammer's rule.

$x + 2y - z = 2$

$2x - 3y + 4z = 8$

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

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14. Solve :

$x - 2y + 3z = 2$

$3x + y - z = 3$

$8x - 2y + 4z = 10$

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15. Solve :

$$\frac{1}{x}+\frac{2}{y}-\frac{1}{z}=1$$
$$\frac{2}{x}+\frac{4}{y}+\frac{1}{z}=5$$
$$\frac{3}{x}-\frac{2}{y}-\frac{2}{z}=0$$ Using Crammer's rule.

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