PhysicsByAaryan

CSIR NET . GATE . JEST . BARC - Physics

Matrices and Linear Algebra - CSIR NET Physics PYQs

Mathematical Physics . All PYQs (2015-2025) with answer key

21 questions . Answer key included

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Q1. [Dec 2016] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2016 Dec	3.5M

The matrix $M = \begin{pmatrix} 1 & 3 & 2 \\ 3 & -1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$ satisfies the equation

1. $M^3 - M^2 - 10M + 12I = 0$
2. $M^3 + M^2 - 12M + 10I = 0$
3. $M^3 - M^2 - 10M + 10I = 0$
4. $M^3 + M^2 - 10M + 10I = 0$

Q2. [Dec 2017] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2017 Dec	3.5M

Consider the matrix equation

$$\begin{pmatrix} 1 & 1 & 1 \\ 1 & 2 & 3 \\ 2 & b & 2c \end{pmatrix}\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$$

The condition for existence of a non-trivial solution and the corresponding normalised solution (upto a sign) is

1. $b = 2c$ and $(x, y, z) = \frac{1}{\sqrt{6}}(1, -2, 1)$
2. $c = 2b$ and $(x, y, z) = \frac{1}{\sqrt{6}}(1, 1, -2)$
3. $c = b + 1$ and $(x, y, z) = \frac{1}{\sqrt{6}}(2, -1, -1)$
4. $b = c + 1$ and $(x, y, z) = \frac{1}{\sqrt{6}}(1, -2, 1)$

Q3. [Dec 2017] . 3.5 marks
Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2017 Dec	3.5M

Let A be a non-singular 3×3 matrix, the columns of which are denoted by the vectors $\vec{a}, \vec{b}$ and $\vec{c}$, respectively. Similarly, $\vec{u}, \vec{v}$ and $\vec{w}$ denote the vectors that form the corresponding columns of $(A^T)^{-1}$. Which of the following is true?

1. $\vec{u} \cdot \vec{a} = 0, \vec{u} \cdot \vec{b} = 0, \vec{u} \cdot \vec{c} = 1$
2. $\vec{u} \cdot \vec{a} = 0, \vec{u} \cdot \vec{b} = 1, \vec{u} \cdot \vec{c} = 0$
3. $\vec{u} \cdot \vec{a} = 1, \vec{u} \cdot \vec{b} = 0, \vec{u} \cdot \vec{c} = 0$
4. $\vec{u} \cdot \vec{a} = 0, \vec{u} \cdot \vec{b} = 0, \vec{u} \cdot \vec{c} = 0$

Q4. [June 2017] . 3.5 marks
Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2017 June	3.5M

Which of the following can not be the eigenvalues of a real 3×3 matrix

1. $2i, 0, -2i$
2. $1,1,1$
3. $e^{i\theta}, e^{-i\theta}, 1$
4. $i, 1, 0$

Q5. [June 2017] . 5.0 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2017 June	5M

Let $\sigma_x, \sigma_y, \sigma_z$ be the Pauli matrices and

$$x'\sigma_x + y'\sigma_y + z'\sigma_z = \exp\left(\frac{i\theta\sigma_z}{2}\right) \times \left[x\sigma_x + y\sigma_y + z\sigma_z\right]\exp\left(-\frac{i\theta\sigma_z}{2}\right).$$

Then the coordinates are related as follows

1. $$\begin{pmatrix} x' \\ y' \\ z' \end{pmatrix} = \begin{pmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix}$$

2. $$\begin{pmatrix} x' \\ y' \\ z' \end{pmatrix} = \begin{pmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix}$$

3. $$\begin{pmatrix} x' \\ y' \\ z' \end{pmatrix} = \begin{pmatrix} \cos\frac{\theta}{2} & \sin\frac{\theta}{2} & 0 \\ -\sin\frac{\theta}{2} & \cos\frac{\theta}{2} & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix}$$

4. $$\begin{pmatrix} x' \\ y' \\ z' \end{pmatrix} = \begin{pmatrix} \cos\frac{\theta}{2} & -\sin\frac{\theta}{2} & 0 \\ \sin\frac{\theta}{2} & \cos\frac{\theta}{2} & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix}$$

Q6. [Dec 2018] . 3.5 marks
Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2018 Dec	3.5M

One of the eigenvalues of the matrix e^A is e^a, where $A = \begin{pmatrix} a & 0 & 0 \\ 0 & 0 & a \\ 0 & a & 0 \end{pmatrix}$. The product of the other two eigenvalues of e^A is

1. e^{2a}
2. e^{-a}
3. e^{-2a}
4. 1

Q7. [Dec 2018] . 5.0 marks
Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2018 Dec	5M

A 4×4 complex matrix A satisfies the relation $A^\dagger A = 4I$, where I is the 4×4 identity matrix. The number of independent real parameters of A is

1. 32
2. 10
3. 12
4. 16

Q8. [June 2018] . 5.0 marks
Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2018 June	5M

Which of the following statements is true for a 3×3 real orthogonal matrix with determinant +1 ?

1. the modulus of each of its eigenvalues need not be 1 , but their product must be 1
2. at least one of its eigenvalues is +1
3. all of its eigenvalues must be real
4. none of its eigenvalues must be real

Q9. [Dec 2019] . 3.5 marks
Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2019 Dec	3.5M

If the rank of an $n \times n$ matrix A is m, where m and n are positive integers with $1 \leq m \leq n$, then the rank of the matrix A^2 is

1. m
2. $m - 1$
3. 2 m
4. $m - 2$

Q10. [June 2019] . 3.5 marks
Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2019 June	3.5M

The element of a 3 × 3 matrix A are the products if its row and column indices $A_{ij} = ij$

(where $i, j = 1,2,3$). The eigenvalues of A are

1. $(7,7,0)$
2. $(7,4,3)$
3. $(14,0,0)$
4. $\left(\frac{14}{3}, \frac{14}{3}, \frac{14}{3}\right)$

Q11. [June 2020] . 3.5 marks
Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2020 June	3.5M

The eigenvalues of the 3 × 3 matrix $M = \begin{pmatrix} a^2 & ab & ac \\ ab & b^2 & bc \\ ac & bc & c^2 \end{pmatrix}$ are

1. $a^2 + b^2 + c^2, 0, 0$
2. $b^2 + c^2, a^2, 0$
3. $a^2 + b^2, c^2, 0$
4. $a^2 + c^2, b^2, 0$

Q12. [June 2021] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2021 June	3.5M

A generic 3×3 real matrix A has eigenvalues 0,1 and 6, and I is the 3×3 identity matrix. The quantity/quantities that cannot be determined from this information is/are the

1. eigenvalue of $(I + A)^{-1}$
2. eigenvalue of $\left(I + A^T A\right)$
3. determinant of $A^T A$
4. rank of A

Q13. [June 2022] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2022 June	3.5M

Two $n \times n$ invertible real matrices A and B satisfy the relation $(AB)^T = -(A^{-1}B)^{-1}$

If B is orthogonal then A must be

1. Lower triangular
2. Orthogonal
3. Symmetric
4. Antisymmetric

Q14. [June 2022] . 5.0 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2022 June	5M

The matrix corresponding to the differential operator $\left(1+\frac{d}{dx}\right)$ in the space of polynomials of degree at most two, in the basis spanned by $f_1 = 1,\ f_2 = x$ and $f_3 = x^2$, is

1. $\begin{pmatrix} 1 & 1 & 0 \\ 0 & 1 & 2 \\ 0 & 0 & 1 \end{pmatrix}$

2. $\begin{pmatrix} 1 & 0 & 0 \\ 1 & 1 & 0 \\ 0 & 2 & 1 \end{pmatrix}$

3. $\begin{pmatrix} 1 & 1 & 0 \\ 0 & 1 & 1 \\ 0 & 0 & 2 \end{pmatrix}$

4. $\begin{pmatrix} 1 & 0 & 0 \\ 1 & 1 & 0 \\ 0 & 1 & 2 \end{pmatrix}$

Q15. [Dec 2023] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2023 Dec	3.5 M

Let M be a 3×3 real matrix such that

$$e^{M\theta} = \begin{bmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$ where θ is a real parameter. Then M is given by

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

Q16. [June 2023] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2023 June	3.5M

The matrix $M = \begin{pmatrix} 3 & -1 & 2 \\ -1 & 2 & 0 \\ 2 & 0 & 1 \end{pmatrix}$ satisfies the equation $M^3 + \alpha M^2 + \beta M + 3 = 0$ if (α, β) are

1. $(-2,2)$
2. $(-3,3)$
3. $(-6,6)$
4. $(-4,4)$

Q17. [June 2023] . 5.0 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2023 June	5M

The matrix $R_{\hat{n}}(\theta)$ represents a rotation by an angle

to the matrix $\begin{pmatrix} -1 & 0 & 0 \\ 0 & -\frac{1}{3} & \frac{2\sqrt{2}}{3} \\ 0 & \frac{2\sqrt{2}}{3} & \frac{1}{3} \end{pmatrix}$, respectively, are

1. $\pi/2$ and $\left(0, -\sqrt{\frac{2}{3}}, \frac{1}{\sqrt{3}}\right)$
2. $\pi/2$ and $\left(0, \frac{1}{\sqrt{3}}, \sqrt{\frac{2}{3}}\right)$
3. π and $\left(0, -\sqrt{\frac{2}{3}}, \frac{1}{\sqrt{3}}\right)$
4. π and $\left(0, \frac{1}{\sqrt{3}}, \sqrt{\frac{2}{3}}\right)$

Q18. [Dec 2024] . 3.5 marks
Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2024 Dec	3.5M

If I is an $n \times n$ identity matrix and $\text{adj}(2I) = 2^k I$, then k is equal to

1. 1
2. n
3. $n-1$
4. 2

Q19. [June 2024] . 3.5 marks
Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2024 June	3.5M

The matrix A is given by $A = \begin{bmatrix} 1 & 2 & -3 \\ 0 & 3 & 2 \\ 0 & 0 & -2 \end{bmatrix}$

The eigenvalues of $3A^3 + 5A^2 - 6A + 2I$, where I is the identity matrix, are

1. 4, 9, 27
2. 1,9,44
3. 1,110,8
4. 4, 110, 10

Q20. [Dec 2025] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2025 Dec	3.5M	MMP

Commutator of two matrices A and B is defined as $[A, B] = AB - BA$ and the anti-commutator as $\{A, B\} = AB + BA$. If $\{A, B\} = 0$. Then we can express $[A, BC]$ as

1. $B\{A, C\}$
2. $-B[A, C]$
3. $-B\{A, C\}$
4. $[A, B]C$

Q21. [June 2025] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2025 June	3.5M	MMP

For the matrix $A = \begin{bmatrix} 2 & -1 & 0 \\ -1 & 3 & 1 \\ 0 & 1 & 0 \end{bmatrix}$, which of the following is true?

1. $A^3 = 5A^2 - 4A - 2$
2. $A^3 = 4A^2 - 6A + 3$
3. $A^3 = 5A^2 - 5A - 1$
4. $A^3 = 8A^2 + 3A - 4$

Answer Key

21 questions . Subject and topic for quick revision

Q. No	Subject	Topic	Answer
Q1	Mathematical Physics	Matrices and Linear Algebra	**3**
Q2	Mathematical Physics	Matrices and Linear Algebra	**4**
Q3	Mathematical Physics	Matrices and Linear Algebra	**3**
Q4	Mathematical Physics	Matrices and Linear Algebra	**4**
Q5	Mathematical Physics	Matrices and Linear Algebra	**2**
Q6	Mathematical Physics	Matrices and Linear Algebra	**4**
Q7	Mathematical Physics	Matrices and Linear Algebra	**4**
Q8	Mathematical Physics	Matrices and Linear Algebra	**2**
Q9	Mathematical Physics	Matrices and Linear Algebra	**1**
Q10	Mathematical Physics	Matrices and Linear Algebra	**3**
Q11	Mathematical Physics	Matrices and Linear Algebra	**1**
Q12	Mathematical Physics	Matrices and Linear Algebra	**2**
Q13	Mathematical Physics	Matrices and Linear Algebra	**4**
Q14	Mathematical Physics	Matrices and Linear Algebra	**1**
Q15	Mathematical Physics	Matrices and Linear Algebra	**2**
Q16	Mathematical Physics	Matrices and Linear Algebra	**3**
Q17	Mathematical Physics	Matrices and Linear Algebra	**4**
Q18	Mathematical Physics	Matrices and Linear Algebra	**3**
Q19	Mathematical Physics	Matrices and Linear Algebra	**4**
Q20	Mathematical Physics	Matrices and Linear Algebra	**3**
Q21	Mathematical Physics	Matrices and Linear Algebra	**1**

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