

EE Mathematics

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2026

In order to practice latex, I tried recreating my latest mathematics exam - second semester, 1st year undergraduate. Most equations I do not remember exactly. Literal numbers have been replaced with numbers (e.g. $a_1, a_2, a, b, \dots$)

1. Solve for X given $A, B, C \in M_{2 \times 2}(\mathbb{R})$

$$\begin{bmatrix} a_1 & a_2 \\ a_3 & a_4 \end{bmatrix} X + \begin{bmatrix} b_1 & b_2 \\ b_3 & b_4 \end{bmatrix} = \begin{bmatrix} c_1 & c_2 \\ c_3 & c_4 \end{bmatrix} \quad (1)$$

2. What does $\det A$ tell us about the matrix (singularity, volume, etc.) and what is their exact relationship?
3. Let $A \in M_{3 \times 3}(\mathbb{R})$ and $\vec{x}, \vec{b} \in M_{3 \times 1}(\mathbb{R})$ denote a system of linear equations in $\mathbb{R}^3$:

$$A\vec{x} = \vec{b} \quad (2)$$

How many solutions are there if:

- (1) $\text{rank}(A) = 3$
- (2) $\text{rank}(A) = 2, \text{rank}([A|b]) = 3$
- (3) $\text{rank}(A) = 2, \text{rank}([A|b]) = 2$
4. What is the relationship between $\vec{x}, \vec{y} \in M_{3 \times 1}(\mathbb{R})$ if $|\vec{x} \times \vec{y}| = 0$
5. Without calculating, think of a valid eigenvalue - eigenvector pair for the given matrix.

$$A = \begin{bmatrix} a & 0 \\ 0 & b \end{bmatrix} \quad (3)$$

6. Define a plane on which lies the given point $A(1, 1, -1)$

7. Find the general solution to the differential equation:

$$\frac{d^3}{dx^3}y(x) = -4x \quad (4)$$

8. Find the general solution to the differential equation:

$$\frac{d^3}{dx^3}y(x) - 3\frac{d^2}{dx^2}y(x) + 3\frac{d}{dx}y(x) - y(x) = 0 \quad (5)$$

9. Find a third-degree polynomial that approximates the function $f(x) = \sin(2x)$
10. Graph the Fourier series expansion of the function $g(x) = 3\cos(x)$ with period $[-\frac{2}{\pi}, \frac{2}{\pi}]$

* Bonus questions

11. Find the line γ that lies in the intersection of two planes Π, Σ .

$$\Pi : x + y = 0 \quad (6)$$

$$\Sigma : x - 2z = 1 \quad (7)$$

What is the vector form equation of γ ?

12. Write out the Fourier series expansion of $f(x)$ with period $P = 1$. No need to write the Fourier coefficients also.