

Cayley Hamilton Theorem



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About Cayley Hamilton



- Author Cayley : (16 August 1821 -26 January 1895) was a British Mathematician. He helped in finding the modern British school of pure mathematics. As a child , Cayley enjoyed solving complete math's problem for amusement . He worked as a lawyer for 14 years.

About sir william Rowan Hamilton



- Sir William Rowan Hamilton : (1805-1865) was an Irish physicist , astronomer, and mathematician , who made important contribution to classical mechanics , optics and algebra .
- Hamilton is said to have shown immense talent at a very early age .

STATEMENT



- The Cayley Hamilton theorem states that a square $n \times n$ matrix. A satisfies own characteristics equation . Thus we can express A^n in term of a finite set of lower powers of A . this fact leads to a simple way of calculating the value of a function evaluated at the matrix A is
- $f(\lambda) = |A - \lambda I|$ is $\lambda^n + a_1 \lambda^{n-1} + a_2 \lambda^{n-2} + \dots + a_{n-1} \lambda + a_n = 0$ where I is the n^{th} order unit matrix and 0 is the n^{th} order zero matrix.

Proof



The characteristics equation for the matrix A is $|A - \lambda I| = 0$ which can be written as $A^n + a_1 A^{n-1} + a_2 A^{n-2} + \dots + a_{n-1} A + a_n I = 0$

Uses of Cayley Hamilton theorem in mathematics and daily life



- 1) inverse and power of matrix
- 2) only inverse of matrix
- 3) in DC circuit
- 4) singular system
- 5) in control system

Matrices are used in many fields like Robotics , Automation , Encryption, Quantum Mechanics, Electrical circuit and 3D visualization and 2D etc.



Example of Cayley Hamilton theorem

$$A = \begin{bmatrix} 1 & 0 & 2 \\ 0 & 2 & 1 \\ 2 & 0 & 3 \end{bmatrix}$$

Its characteristic polynomial is $|A - \lambda I| = 0$

Hence the characteristic equation is $\lambda^3 - 6\lambda^2 + 7\lambda + 2 = 0$

By Cayley Hamilton theorem $A^3 - 6A^2 + 7A + 2I = 0$



Thanks