TENSORS: ELEMENTARY PROPERTIES

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1. Introduction

Tensors are mathematical quantities used to represent physical quantities that require more than magnitude and direction. They provide a coordinate-independent formulation of physical laws.

2. Definition of Tensor

A tensor is a mathematical object whose components transform according to a definite law under a change of coordinates.

3. Rank (Order) of Tensor

The rank of a tensor is the number of indices required to specify it. Scalars are rank zero, vectors rank one, and higher-order tensors accordingly.

4. Types of Tensors

Scalars, vectors, second-order tensors, contravariant, covariant, and mixed tensors.

5. Transformation Law

Contravariant tensors transform with partial derivatives of new coordinates with respect to old ones, while covariant tensors transform inversely.

6. Elementary Properties

Addition, subtraction, scalar multiplication, tensor multiplication, contraction, symmetry, antisymmetry, and zero tensor.

7. Kronecker Delta

Defined as δ_{ij} = 1 for i=j and 0 for i≠j. It acts as the identity tensor.

8. Physical Importance

Tensors are essential in elasticity, electromagnetism, fluid mechanics, and relativity.

9. Conclusion

Tensors generalize scalars and vectors and ensure the invariance of physical laws under coordinate transformations.