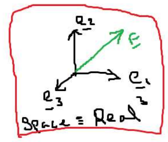
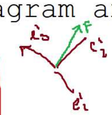
ME1020

Lecture-3

4/5/22

Components of forces in space; Equilibrium of a particle and a rigid body. Trusses, and analysis of forces in trusses. Internal forces-normal or axial force, shear force, bending moment, torsional moment; Sign convention for different internal forces; Application of the method of sections to determine internal forces; Relationship between applied load, shear force, and bending moment; Method of superposition to obtain shear force diagram and bending moment diagram.





Invariants

$3^0 = 1 \rightarrow$ Scalar ↗ Zeroes

$3^{1-1} = 1$ $\quad 3^1 = 3 \rightarrow \underline{V} = v_1 \underline{e}_1 + v_2 \underline{e}_2 + v_3 \underline{e}_3$

$3^{2-1} = 3$ $\quad 3^2 = 9 \rightarrow$ Tensor $\quad \boxed{\text{Stress}}$

3^{n-1} $\quad 3^n$ $\quad$ tensor

Vector — direction — Magnitude

e.g. magnitude, invariant, coordinate transform

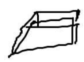
$F = F_1 e_1 + F_2 e_2 + F_3 e_3$

$F = F_1' e_1' + F_2' e_2' + F_3' e_3'$

$F \cdot F = F \cdot F$ Inner product

Basis $\quad e_1 \perp e_2 \perp e_3$

$a \quad b \quad c$



LI vectors any given vector in space (construct) including zero vector

$\underline{0} = v_1 e_1 + v_2 e_2 + v_3 e_3$

$v_1 = v_2 = v_3 = 0$

Examples

$\underline{OP}$ = position vector

Velocity

acceleration

Force

Scalar

$a + b$ = scalar

$a * b$ = scalar

$a \div b$ = scalar

Vector

$\underline{a} + \underline{b}$ = vector $\quad 3^1$

$\underline{a} \cdot \underline{b}$ (dot) = scalar $\quad 3^0$

$\underline{a} \wedge \underline{b}$ (cross) = vector $\quad 3^1$

$\underline{a} \otimes \underline{b}$ (Tensor product) = Tensor $\quad 3^2$

$\underline{d}$: displacement (vector)

$\underline{F}$: Force (vector)

Energy = $\underline{F} \cdot \underline{d}$ = Scalar