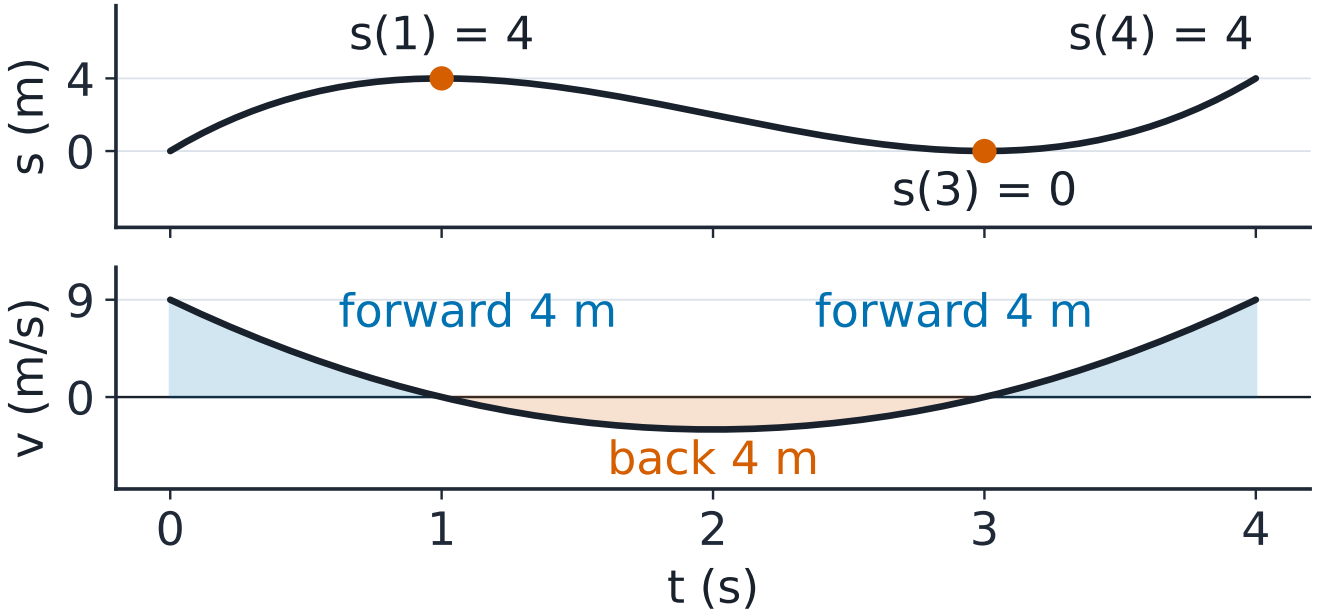
Exercise walk-through

2.5
Vector calculus

University Mechanical Engineering

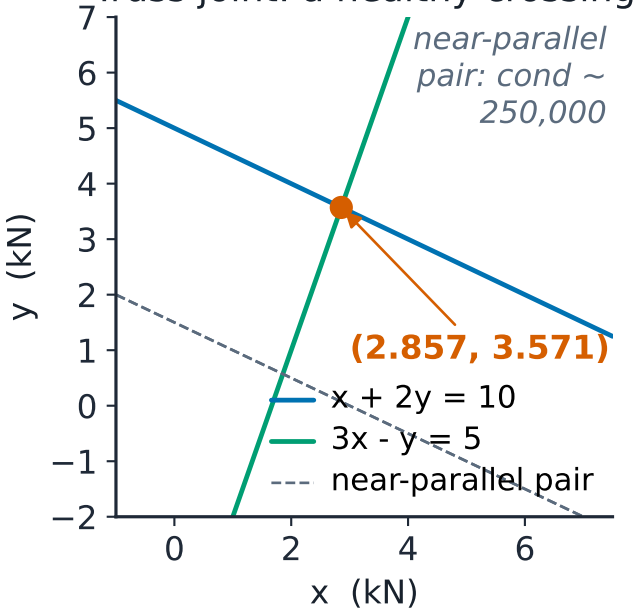
Calculus: the trace is a dictionary



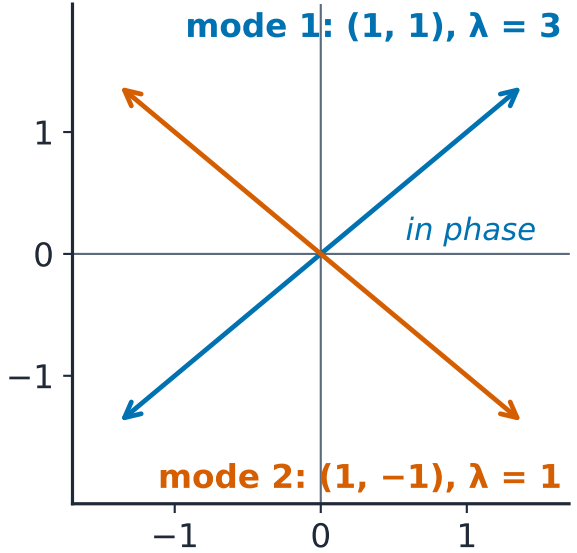
Displacement 4 m but distance **12 m**: v changes sign at t = 1 and 3.

Linear algebra: the condition number prices trust

Truss joint: a healthy crossing



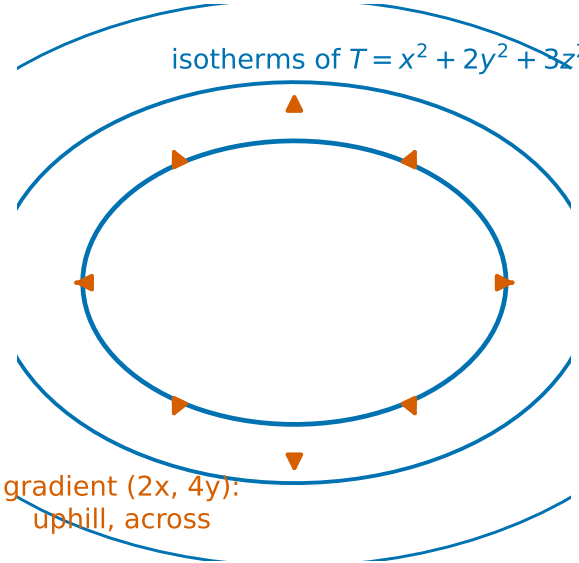
The rig matrix: two mode shapes



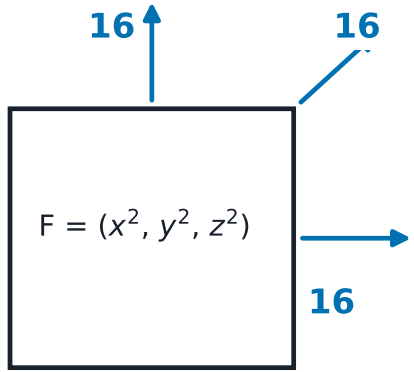
Truss lines cross at **(2.857, 3.571)** kN; rig modes (1, 1) and (1, −1).

Vector calculus: count what leaves

Fields: T rises at 7.483 K/m; q = -40 grad T



Flux 48, counted two ways



surface flux: 16 + 16 + 16 = 48

divergence: 2(x+y+z) dV = 48

∇T gives **7.483** K/m; **flux 48** by surface = **48** by **divergence**.

Exercises 2.1·2.3

2.1 ∇T at (1, 1, 1), its magnitude, and the heat flux vector with its magnitude (one decimal). [4]

2.2 The flux of $\mathbf{F} = (x^2, y^2, z^2)$ through the cube $[1,3]^3$: by faces, and by the divergence theorem. [4]

2.3 $\nabla \times \mathbf{G}$ at (1, 1, 2). [3]

Exercises 2.1·2.3

2.1 ∇T at (1, 1, 1), its magnitude, and the heat flux vector with its magnitude (one decimal). [4]

2.1

- $\nabla T = (6x, 2y, 4z) = (6, 2, 4)$; $|\nabla T| = 7.483$ K/m.
- $\mathbf{q} = -40\nabla T = (-240, -80, -160)$ W/m2; $|\mathbf{q}| = 40 \times 7.483 = 299.3$ W/m2.

2.2 The flux of $\mathbf{F} = (x^2, y^2, z^2)$ through the cube $[1, 3]^3$: by faces, and by the divergence theorem. [4]

2.2

- Far faces at 3: $9 \times 4 = 36$ each, 108; near faces at 1: $1 \times 4 = 4$ each, 12: net 96.
- $\int 2(x + y + z)\, dV = 2 \times 6 \times 8 = 96$.

2.3 $\nabla \times \mathbf{G}$ at (1, 1, 2). [3]

2.3

- $\nabla \times \mathbf{G} = (x, -y, 0)$; at (1,1,2): $(1, -1, 0)$.

Exercise 2.4

2.4 The grille has one panel missing. State the theorem’s status and the standard repair in one line each. [3]

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2.4

- Open surface: the theorem does not apply directly.
- Repair: patch the hole, apply the theorem, subtract the patch.