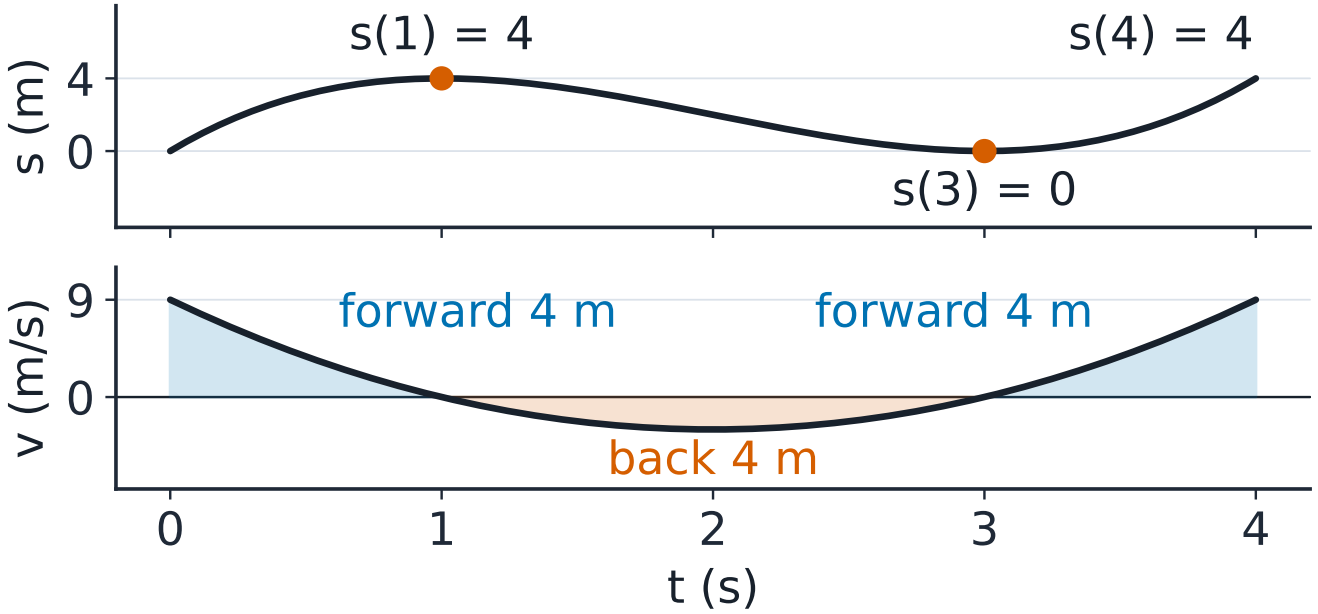
Exercise walk-through

2.2
Linear algebra

University Mechanical Engineering

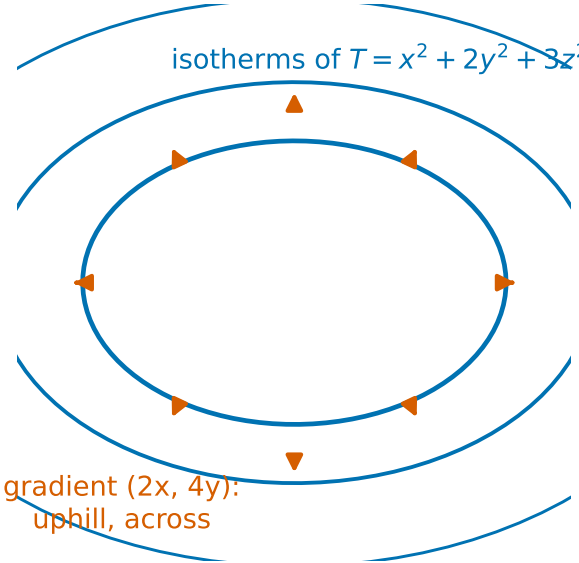
Calculus: the trace is a dictionary



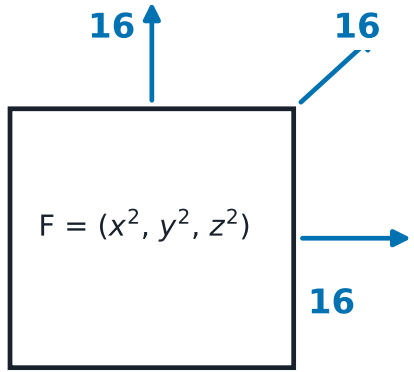
Displacement 4 m but distance **12 m**: v changes sign at t = 1 and 3.

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**.

The project sheet, reproducible

1. **Motion Displacement** 4 m, distance 12 m; fillet volume $\pi \times 17.067 = 53.62$ m^3.
2. **Algebra** Truss joint (2.857, 3.571) kN; eigenvalues 3, 1 with modes (1, 1), (1, -1); condition numbers 3 and 250,008.
3. **Engine** ω_n $= 5$, $\zeta = 0.2$, ω_d $= 4.899$; first minimum -0.527; M$(1) = 2.5$, peak 2.552 at r $= 0.959$. Euler $\div 2$, trapezoid $\div 4$, Simpson $\div 15.9$. **Flux** $48 = 48$; circulation 2π; ∇^2T $= 12$. u_c $= 0.0042$, U $= 0.008$, A $= 490.9 \pm 0.3$ mm^2.

Exercises 2.1·2.2

2.1 Solve $2x + 3y = 12$, $x - y = 1$ and verify both equations. [3]

2.2 The matrix with rows (4, 1) and (1, 4): its eigenvalues and eigenvectors. [4]

Exercises 2.1·2.2

2.1 Solve $2x + 3y = 12$, $x - y = 1$ and verify both equations. [3]

2.1

- Subtract/eliminate: $x = 3$, $y = 2$.
- Check: $6 + 6 = 12$ and $3 - 2 = 1$.

2.2 The matrix with rows (4, 1) and (1, 4): its eigenvalues and eigenvectors. [4]

2.2

- $(4 - \lambda)^2 - 1 = 0$: $\lambda = 5$ and 3.
- $(1, 1)$ for 5; $(1, -1)$ for 3.

Exercises 2.3·2.4

2.3 The matrix with rows (1, 1) and (1, 1.0001): the condition number (nearest thousand), and what it says about the solved answer. [3]

2.4 An initial displacement (2, 0) of the two-mass rig of 2.2. Express it in the mode basis and state each mode's share. [4]

Exercises 2.3·2.4

2.3 The matrix with rows (1, 1) and (1, 1.0001): the condition number (nearest thousand), and what it says about the solved answer. [3]

2.3

- $\kappa \approx 40{,}000$ (nearest thousand).
- The rows are nearly parallel: a data nudge of 10^{-4} can move the answer by whole units - report the conditioning, not just the solution.

2.4 An initial displacement (2, 0) of the two-mass rig of 2.2. Express it in the mode basis and state each mode's share. [4]

2.4

- $(2, 0) = 1 \cdot (1, 1) + 1 \cdot (1, -1)$ - equal shares.
- Each mode then oscillates at its own frequency; the split is the prediction.