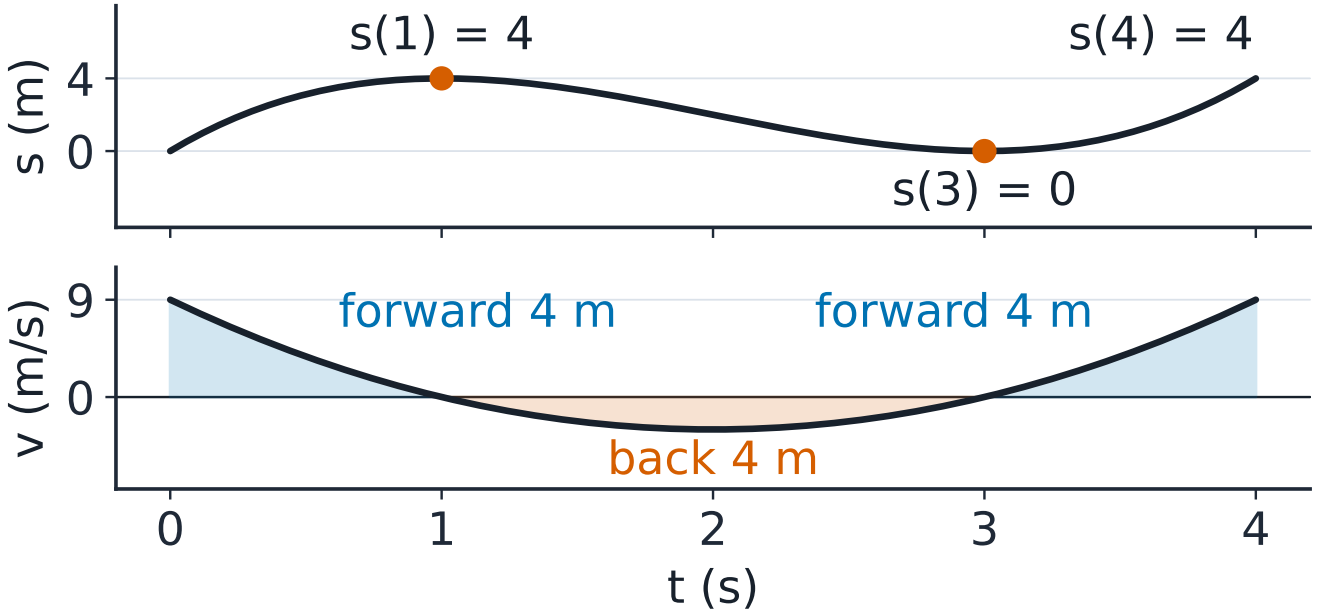
Exercise walk-through

2.1
Calculus for engineering

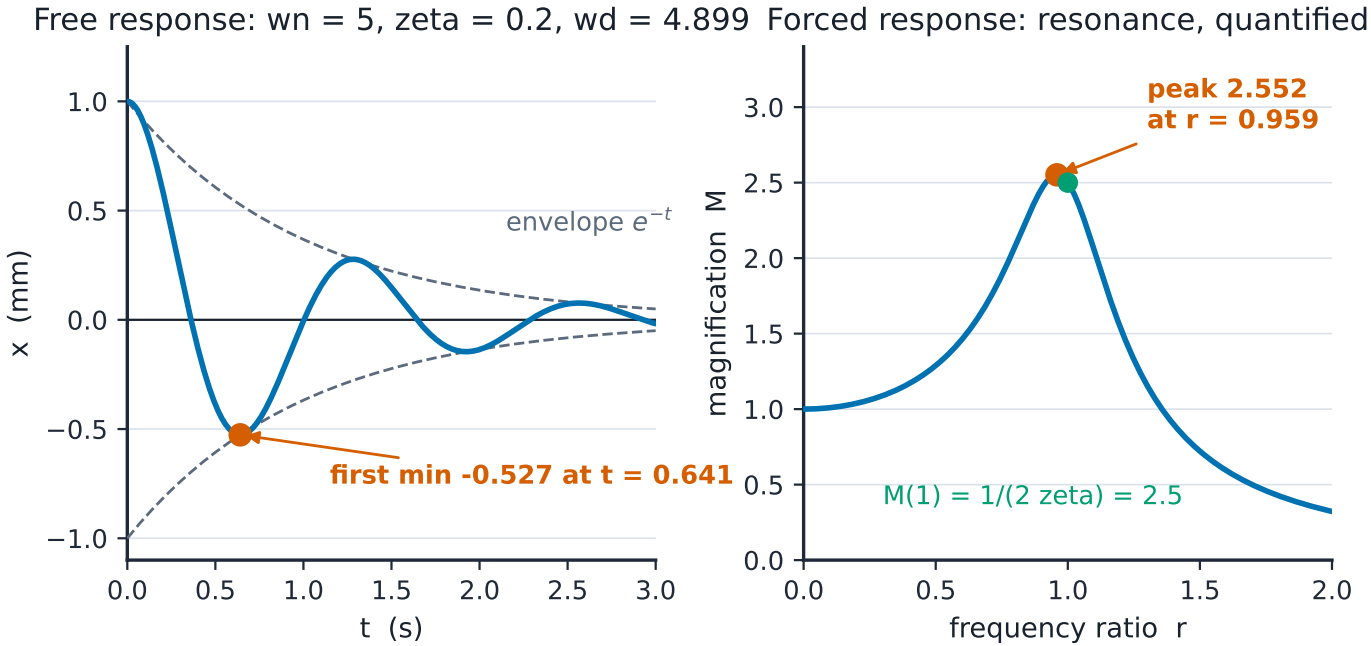
University Mechanical Engineering

Calculus: the trace is a dictionary



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

Differential equations: the rig is the equation



$\zeta = 0.2$: first minimum **−0.527** at t = 0.641; peak **2.552** at r = 0.959.

Numerical methods in action: h from the budget

1. **Budget** Error $\approx 0.19h$ for Euler (the measured rate), so h $\approx$ 5e−4 - about two thousand steps.
2. **Escalate** The RK-class stepper this course builds toward runs h ≈ 0.1 - ten steps, two hundred times fewer, same answer.
3. **Floor** Push Simpson to a million panels and round-off ($\sim$1e−10) dominates - the measured flattening IS the floor.

Exercises 2.1·2.3

2.1 The times $u = 0$, the sign of u on each interval, and $u(0)$. [3]

2.2 With $U(0) = 0$: $U(1)$, $U(3)$ and $U(4)$ (three decimals), then the displacement and the distance over 0 to 4 s. [4]

2.3 The acceleration $a(t)$ and its zero. [2]

Exercises 2.1·2.3

2.1 The times $u = 0$, the sign of u on each interval, and $u(0)$. [3]

2.1

- $2t^2 - 8t + 6 = 0$ gives $t = 1$ and $t = 3$; $u(0) = 6$ m/s.
- Positive on (0,1) and (3,4); negative on (1,3).

2.2 With $U(0) = 0$: $U(1)$, $U(3)$ and $U(4)$ (three decimals), then the displacement and the distance over 0 to 4 s. [4]

2.2

- $U(t) = \frac{2}{3}t^3 - 4t^2 + 6t$: $U(1) = 2.667$, $U(3) = 0$, $U(4) = 2.667$ m.
- Displacement $= 2.667$ m; distance $= 2.667 + 2.667 + 2.667 = 8.000$ m.

2.3 The acceleration $a(t)$ and its zero. [2]

2.3

- $a = 4t - 8$, zero at $t = 2$ s.

Exercise 2.4

2.4 The guide fillet $y = x(3 - x)$ is revolved about the x-axis from 0 to 3 m. The volume (two decimals), with the integral set out and one check stated. [5]

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2.4

- $\pi \int_0^3 (9x^2 - 6x^3 + x^4)dx = \pi(81 - 121.5 + 48.6) = \pi \times 8.1 = 25.45$ m3.
- Check: numeric quadrature agrees to two decimals (or shell agreement about the stated axis).