ODE integration, root finding, and parameter estimation — review sheet

Use this after attempting the worked examples and practice. Explain each claim in words before calculating.

Key ideas

- One model can support several distinct numerical questions.
- A rate law and initial value define an initial-value problem.
- Exact-model comparisons check numerical implementation, not real-world validity.
- A bracketed root needs a suitable continuous residual and endpoint evidence.
- Interpolation adds a between-sample assumption and has a declared domain.
- Optional optimization fits a parameter within bounds; residuals and independent evidence still matter.

Common errors and repairs

Giving k units of minutes. k must have reciprocal-minute units so k times t is dimensionless.

Treating solver tolerance as a guaranteed global error bound. Measure the relevant error against an independent reference when available.

Calling a target equal to ambient a finite crossing. The exponential reaches that limit only asymptotically.

Treating more interpolation plot points as new measurements. The same knots and linear assumption define all those plotted values.

Treating the best tested parameter as model validation. A smaller residual does not establish the physical model; compare independent observations.

Retrieve without your notes

- What happens when k is zero?
- Why compare a root with both an analytic time and a residual?
- What is the interpolation domain?
- What must be added to assess a model beyond synthetic recovery?

Readiness check

- State a one-state cooling model with consistent time and temperature units.

- Run a supplied initial-value solver and compare its output with an exact solution of the same model.
- Translate a target-temperature question into a bracketed scalar root.
- Interpolate inside a sampled interval and explain why interpolation is not the ODE model.
- Use limiting behavior and residuals to check numerical outputs.