

MATH120 syllabus

The following tentative syllabus is subject to minor changes.

Introduction: The question (1 week)

- Why do we need mathematics/quantitative tools in science?
- How to read a problem (qualitative → quantitative)
- What mathematics language means and how to write it.
- Aspects of problem-solving.

Module 1: Measuring the natural world (2 weeks)

- Types of measurements.
- How do we organise, map and visualise measured quantities.
- What are the relevant parameters, variables and scales?
- How can quantities be manipulated (non-dimensionalisation, units etc.).
- Techniques for estimating quantities.

Module 2: Empirical analysis (2 weeks)

- Quantifying the data mathematically (size, shape, outliers, etc.).
- Forming relationships between variables (linear and nonlinear regression, log plots).
- Quantifying error and uncertainty

Module 3: Modelling Change in Time (2 weeks)

- Rate of change of a function.
- Modelling with first-order differential equations (DEs).
- Solving DEs numerically.
- Cumulative change (numerical integration).

Module 4: Computing with mathematical models (2 weeks)

- Linear approximation and error propagation.
- Finding roots of equations (bisection, Newton-Raphson, ...).
- Optimisation.
- Interpolation and curve fitting (splines).

Module 5: Higher-Dimensional Models (2 weeks)

- 3D coordinates, solving problems with vectors.
- Surface fitting.
- Estimating area, volumes.

Wrap up (2 weeks)

- How do quantitative approaches help answer science questions (predictions, better measurement techniques, etc)
- What effect do the assumptions have?
- Iterative process, refining models, etc.
- How does this relate to the real world?
- Presenting science findings orally and in writing