# MATH0079 Cosmology

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| *Year:* | 2024–2025 |
| *Code:* | MATH0079 |
| *Level:* | 7(UG)/7(PG) |
| *Normal student group(s):* | UG Year 4 Mathematics degrees<br>PG MSc Mathematical Modelling |
| *Value:* | 15 credits (= 7.5 ECTS credits) |
| *Term:* | 2 |
| *Assessment:* | 70% examination, 10% midterm examination, 20% coursework |
| *Normal Pre-requisites:* | MATH0025 |
| *Lecturer:* | Dr B Hartmann |

*Course Description*

Cosmology studies the history and the structure of the universe. Observations show the homogeneity and isotropy of the universe on large scales. For the homogenous and isotropic spacetimes, the equations of general relativity reduce to two ordinary differential equations. These cosmological equations govern the evolution of the universe. We study these equations in detail, and show how observations are affected by the expansion and curvature of the universe. The course covers the astronomical methods used to determine the expansion rate (i.e., the Hubble constant) and the mass density of the universe. Physical processes in the early universe such as nucleosynthesis, the formation of the microwave background, and galaxy formation will also be studied. The course begins with a concise introduction to the differential-geometric methods and ends with advanced topics including inflation and cosmological perturbations.

A good working knowledge of General Relativity is essential for many parts of this course.

*Recommended Texts*

(i) Boehmer, *Introduction to General Relativity and Cosmology* World Scientific in press.

(ii) Dodelson, *Modern Cosmology* (Academic Press).

(iii) Weinberg, *Cosmology* (Oxford University Press).

(iv) Liddle, *An Introduction to Modern Cosmology* (Wiley-Blackwell).

(v) Liddle & Lyth, *The Primordial Density Perturbation: Cosmology, Inflation and the Origin of Structure* (Cambridge University Press).

*Detailed Syllabus*

- Mathematical introduction.
- Cosmological models of Friedman-Robertson-Walker-Lemaitre.
- Cosmic matter: energy-momentum and equation of state.
- Density parameters.
- The big bang model: exact cosmological solutions.

- Observations in an expanding universe.
- The redshift versus distance relation.
- The cosmic microwave background.
- Modern cosmology.
- Early universe: Inflation and cosmological perturbations.