MAGIC Mathematics Consortium - Full Module Catalogue (Current Academic Year) - St Anselm's College, Cambridge

This catalogue provides concise 50-word descriptions of all modules offered by the MAGIC Mathematics Consortium in the current academic year. These modules are available to Fourth-Year students of St Anselm's College as optional academic enrichment. Students may take up to five modules per term. Completion does not influence honours or degree classification.

MAGIC002 – Differential Topology and Morse Theory

Introduces core ideas in smooth manifolds, transversality, critical points, Morse functions, and handle decompositions. Students learn how topology changes under smooth deformations and how Morse theory connects differential and algebraic topology. Suitable for students aiming toward geometry, topology, or mathematical physics.

MAGIC009 – Category Theory

Provides the abstract framework unifying mathematical structures. Covers categories, functors, natural transformations, equivalences, limits, adjunctions, and Yoneda's lemma. Emphasises structural reasoning and prepares students for advanced fields such as algebraic geometry, homotopy theory, and higher-category mathematics.

MAGIC020 – Dynamical Systems

Explores qualitative behaviour of systems defined by differential equations or maps. Topics include phase portraits, fixed points, stability, bifurcation theory, attractors, and chaotic dynamics. Applications span physics, biology, engineering, and nonlinear modelling, developing intuition for long-term system behaviour.

MAGIC022 – Mathematical Methods

Develops analytical tools for applied mathematics. Topics include asymptotic methods, perturbation theory, integral transforms, Green's functions, and complex-variable methods. Provides essential preparation for advanced study in applied analysis, PDEs, mathematical physics, and fluid dynamics.

MAGIC040 – Operator Algebras

Introduces C*-algebras, Banach algebras, representations, states, ideals, and spectral theory. Examines the deep interplay between functional analysis, topology, and quantum theory. Suitable for students interested in mathematical physics, noncommutative geometry, or operator-theoretic methods.

MAGIC049 – Modular Forms

Studies holomorphic modular forms, q-expansions, Hecke operators, modular curves, and connections with number theory. Emphasises the analytic and algebraic structure of modular forms and their deep arithmetic applications, including elliptic curves and L-functions.

MAGIC050 – Set Theory

Introduces foundational set theory: ordinals, cardinals, ZFC axioms, the cumulative hierarchy, transfinite recursion, and the continuum problem. Provides conceptual grounding for logic, topology, and foundational mathematics.

MAGIC057 – Spectral Theory of ODE Operators

Develops spectral theory for Sturm–Liouville and related differential operators. Covers eigenfunction expansions, self-adjoint extensions, singular operators, and applications to mathematical physics. Emphasises connections between operator theory and differential equations.

MAGIC061 – Functional Analysis

Examines Hilbert and Banach spaces, bounded operators, duality, spectral theory, and operator algebras. Provides core analytical foundations used in PDEs, harmonic analysis, quantum mechanics, and modern analysis.

MAGIC063 – Differentiable Manifolds

Introduces smooth manifolds, tangent spaces, differential forms, partitions of unity, Lie groups, and integration on manifolds. Establishes geometric tools essential for topology, geometry, and mathematical physics.

MAGIC073 – Commutative Algebra

Studies rings, modules, ideals, localisations, primary decomposition, dimension theory, and homological methods. Forms the algebraic backbone of algebraic geometry and number theory.

MAGIC074 – Algebraic Geometry

Explores varieties, morphisms, coordinate rings, projective geometry, Hilbert's Nullstellensatz, dimension theory, and sheaf-theoretic ideas. Essential for students pursuing pure mathematics or theoretical physics.

MAGIC081 – String Theory

Introduces classical and quantum aspects of string theory: worldsheet actions, conformal symmetry, compactification, and basic superstring structures. Bridges advanced physics and geometry.

MAGIC085 – Metric Number Theory

Examines Diophantine approximation, Hausdorff dimension, measure-theoretic methods, and distribution properties of number-theoretic sets. Connects geometry, measure theory, and analytic number theory.

MAGIC098 – Adaptive Finite Element Methods

Studies numerical approximation of PDEs using adaptive mesh refinement, error estimators, and convergence theory. Applications to computational physics and engineering.

MAGIC099 – Numerical Methods in Python

Introduces computational techniques implemented in Python: numerical linear algebra, root-finding, interpolation, ODE solvers, and scientific computing workflows. Practical preparation for computational research.

MAGIC112 – Computational Algebra and Geometry

Explores polynomial ideals, Gröbner bases, elimination, and computational techniques in algebraic geometry. Useful for applications in robotics, coding theory, and symbolic computation.

MAGIC116 – Measure Theory and Ergodic Theory

Covers sigma-algebras, measures, integration, ergodicity, invariant measures, and dynamical systems. Forms a bridge between analysis, probability, and dynamical systems.

MAGIC118 – Optimal Transport – Theory and Applications

Introduces optimal transport, Wasserstein metrics, Kantorovich duality, and applications in PDEs, geometry, probability, and data science. Emphasises analytical and geometric viewpoints.