

Supplementary Material S1

Mathematics Curriculum Topics Covered in the Study Courses

The following table provides a detailed overview of the mathematical topics covered in each of the three core mathematics courses examined in this study: Calculus II (Advanced), Linear Algebra, and Ordinary Differential Equations. Topics are organized by course and thematic area, reflecting the official course syllabi as implemented during the study period (2018–2020).

Course	Topic Area	Specific Subjects Covered
Calculus II (Advanced)	Improper Integrals	- Definition and convergence of improper integrals
		- Integrals with infinite limits of integration
		- Integrals with discontinuities (undefined endpoints)
		- Convergence and divergence tests
	Series and Sequences	- Infinite series with constant terms
		- Convergence and divergence of infinite series
		- Power series and radius of convergence
	Multivariable Functions	- Level curves and level surfaces
		- Limits and continuity of multivariable functions
		- Partial derivatives
		- Differentiability of multivariable functions
		- Chain rule for multivariable functions
		- Directional derivative and gradient
		- Extrema and saddle points (two variables)
		- Constrained optimization — Lagrange multipliers (two variables)
		- Constrained optimization — Lagrange multipliers (three variables)
		- Absolute extrema on closed bounded sets
		- Double integrals and area calculations in space
Linear Algebra	Systems of Linear Equations	- Definition and solution methods
		- Row reduction (Gaussian and Gauss–Jordan elimination)
		- Number of solutions and post-reduction analysis
		- Parametric systems — investigation with parameters
	Matrix Algebra	- Matrix operations and algebraic properties
		- Matrix arithmetic and scalar multiplication
		- Inverse matrices and their properties
		- Elementary matrices
		- Applications of matrices
	Determinants	- Definition and computation of determinants
		- Properties of determinants

		- Applications: solving systems, finding inverse matrices
	Vector Spaces	- Vector spaces and subspaces
		- Basis and dimension
		- Properties of bases
		- Coordinates and change-of-basis matrix
		- Theoretical justification of the change-of-basis process
	Linear Transformations	- Definition and properties of linear transformations
		- Kernel and image of a linear transformation
		- Matrix representation of a linear transformation
		- Relationship between change-of-basis and transformation matrices
	Eigenvalues and Eigenvectors	- Definition of eigenvalues and eigenvectors
		- Eigenspaces
		- Finding eigenvalues and eigenvectors
		- Diagonalization of matrices
		- Applications: computing matrix powers
Ordinary Differential Equations	Introduction and First-Order ODEs	- Review of selected integration techniques
		- Introduction to ordinary differential equations
		- Classification of differential equation types
		- Separation of variables
		- Geometric and applied problems (growth/decay, Newton's law of cooling)
	First-Order ODEs — Solution Methods	- Homogeneous first-order equations
		- Exact equations
		- Integrating factors (dependent on x or y)
		- Existence and uniqueness theorem
		- Linear first-order equations (Bernoulli equation)
	Second-Order ODEs	- Homogeneous and non-homogeneous second-order equations
		- General solution, method of undetermined coefficients
		- Wronskian
		- Operator method
	Laplace Transforms	- Standard and inverse Laplace transforms
		- Step functions, piecewise and periodic functions
		- Solving second-order ODEs using Laplace transforms
	Higher-Order ODEs	- Homogeneous and non-homogeneous n-th order equations
	Systems of Differential Equations	- Homogeneous and non-homogeneous systems of ODEs
		- Matrix diagonalization and substitution methods

Note: Topic sequencing reflects the order presented in the official syllabi. The total instructional hours per course were identical across the traditional and intensive learning models (84 hours per course).