CALCULUS A(1) SYLLABUS
TSINGHUA UNIVERSITY FALL 2022

1. Numbers

- Numbers: integers, rational numbers and real numbers.
- Properties of real numbers: algebraic operations, inequalities and the existence of supremum/infimum.
- Intervals.
- The absolute value.

2. Functions of one real variable

- Functions and their graphs.
- Combining functions, shifting and scaling graphs, trigonometric functions.
- Precise definition of the limit of a function or a sequence.
- One-sided Limits.
- Continuity.
- Limits involving infinity.
- Asymptotes of graphs.

3. Derivatives

- Tangents and the derivative at a point.
- The derivative as a function.
- Differentiation rules.
- Derivatives of trigonometric functions.
- The chain rule.
- Implicit differentiation.
- Linearization.

4. Applications of derivatives

- Extreme values of functions.
- The mean value theorem.
- Monotonic functions and the first derivative test.
- Concavity, convexity and curve sketching.
- Indeterminate forms and l'Hôpital's rule.
- Antiderivatives.

5. Integrals

- Area and estimating with finite sums.
- Limits of finite sums.
- The definite integral.
- The fundamental theorem of calculus.
- Indefinite integrals and the substitution method.
- Substitutions and the area between curves.

6. The applications of definite integrals

- Volumes using cross-sections.
- Volumes using cylindrical shells.
- Arc length.
- Areas of surfaces of revolution.

7. Transcendentals functions

- Inverse functions and their derivatives.
- Natural logarithms.
- Exponential functions.
- Inverse trigonometric functions.
- Hyperbolic functions.
- Relative rates of growth.

8. Techniques of integration

- Using basic integration formulas.
- Integration by parts.
- Trigonometric integrals.
- Trigonometric substitutions.
- Integration of rational functions by partial fractions.
- Improper integrals.

9. First-order differential equations

- Solutions, slope fields, and Euler's method.
- First-order linear equations.
- Applications.

10. Ordinary differential equations (ODE)

- Higher-order differential equations whose orders can be reduced.
- Higher-order linear differential equations
  1. Structure of solutions: the homogeneous case
  2. Structure of solutions: the non-homogeneous case
- Homogeneous linear differential equations with constant coefficients.
  1. Second-order Case
  2. General Case