THE CHINESE UNIVERSITY OF HONG KONG
Department of Mathematics
MATH1010
Syllabus

Main reference: Thomas' Calculus: Weir and Hass, Pearson

- Prerequisite:
  Exponential function, Logarithmic function, *Radian measure, Trigonometric functions, *Trigonometric identities, Binomial theorem, *Mathematical induction, Definition of derivative
  * Topics not covered in M1.

- Week 1
  Preliminary Knowledge:
  Set notations, Definition of functions, Domains and codomains, Injective, Surjective and Bijective functions, Inverse functions, Even and Odd functions, Periodic functions, Functions involving absolute value, Piecewise defined functions.
  Note: Rough introduction of the terminologies only. Examples of polynomial, rational, radical functions, and their graphs are used to illustrate the concepts instead of rigours definitions.

- Week 2-4
  Limits and Continuity:

  1. Limits of infinite sequences (intuitive meaning only, no $\epsilon - N$), Arithmetic of limits (No proof)
  2. Statement of sandwich theorem (No proof), Using sandwich theorem to evaluate limits (e.g. $\lim\limits_{n\to\infty} \frac{(-1)^n}{n} = 0$, then $\lim\limits_{n\to\infty} \frac{2^n}{n!} = 0$)
  3. Using monotone convergence theorem (no proof of monotone convergence theorem) to prove existence of limits of certain sequences (e.g. $\lim\limits_{n\to\infty} \left(1+\frac{1}{n}\right)^n$ or recursive sequences)
  4. Limits of functions (intuitive meaning using graphs only, no $\epsilon - \delta$), One-sided and two-sided limits, Sequential criterion of limits functions, using sequential criterion to prove that certain limits (e.g. $\lim\limits_{x\to 0} \sin\left(\frac{1}{x}\right)$) do not exist.
  5. $\lim\limits_{x\to 0} \dfrac{\sin x}{x}$, $\lim\limits_{x\to 0} \dfrac{e^x - 1}{x}$, $\lim\limits_{x\to 0} \dfrac{\ln(1+x)}{x}$
  6. Limits at infinity, $\lim\limits_{x\to+\infty} \dfrac{x^k}{e^x}$, $\lim\limits_{x\to+\infty} \dfrac{(\ln x)^k}{x}$
  7. Continuity of functions (Piece-wise defined functions and examples like $f(x) = \begin{cases} \frac{\sin x}{x}, & x \neq 0 \\ 1, & x = 0 \end{cases}$)

- Week 5-6
  Differentiation:

  1. Definition of derivative
  2. Differentiability of functions
  3. Derivatives of exponential, logarithmic and trigonometric functions
  4. Product and quotient rule

5. Chain rule
6. Derivatives of piecewise defined functions, Continuous but not differentiable functions, Functions with discontinuous derivatives
7. Implicit differentiation, logarithmic differentiation
8. Derivatives of inverse trigonometric functions, Derivatives of inverse functions
9. Higher order derivatives

- Week 7-8
  Application of differentiation:

  1. First and Second derivative test
  2. Extremum values of functions on bounded and unbounded intervals
  3. Word problems in extremum values and rate of change
  4. Convexity and concavity, Point of inflection, Horizonal, vertical and oblique asymptotes
  5. Curve sketching (examples: $y = \dfrac{x^2 - x + 4}{x + 3}$, $y = |x^2 - 3x + 2|$, $\sqrt{\frac{3x+5}{x-2}}$)
  6. Mean value theorem (No proof)
  7. Inequalities (e.g. Prove that $(1 + x)^p > 1 + px$ for $x > 0, p > 1$)
  8. L'Hôpital's rule, Limits of indeterminate forms
  9. Taylor series (Finding Taylor series, e.g. $\sqrt{1 - 3x}$, $\ln(1 + x^2)$, $\tan^{-1} x$, no error term)

- Week 9-11
  Indefinite Integration:

  1. Primitive functions, Definition of indefinite integral, Formulae for indefinite integrals
  2. Integration by substitution
  3. Trigonometric integrals
  4. Integration by parts, Reduction formula
  5. Trigonometric substitution
  6. Integration of rational functions, t-substitution

- Week 12-13
  Definite Integration:

  1. Riemann sum, Definition of definite integral
  2. Evaluating limits by integrals
  3. Fundamental Theorem of Calculus
  4. Finding definite integral by Fundamental Theorem of Calculus
  5. Derivatives of functions defined by definite integrals