

Hong Kong Baptist University
Faculty of Science
Department of Mathematics

Title (Units): MATH 3640 THEORETICAL NUMERICAL ANALYSIS (3,3,0)

Course Aims: This course provides a theoretical understanding of the major ideas of numerical analysis. Emphasis is placed on the study of underlying principles, error bounds, convergence theorems, etc. in the area of numerical analysis.

Prerequisite: MATH2140 Numerical Methods I

Prepared by: T. Tang, X. N. Wu, W.M. Xue

Learning Outcomes (LOs):

Upon successful completion of this course, students should be:

No.	Learning Outcomes (LOs)
	Knowledge
1	Able to understand Linear Spaces and Norms
2	Able to understand Banach, Hilbert space
3	Able to understand approximation of function by polynomials
4	Able to explain the underlying principles of interpolation, extrapolation, numerical integration and numerical differentiation
5	Able to understand Sobolev spaces
6	Able to explain fundamental concepts and principles of Galerkin method
	Skills
7	Able to apply the approximation theory
8	Able to manipulate numerical integrations
9	Able to perform interpolation and approximation in Sobolev spaces
	Attitude
10	Able to appreciate the diversity of the applications of mathematical theories

Assessment:

No.	Assessment Methods	Weighting	Remarks
1	Continuous Assessment	30%	Continuous assessment is designed to measure how well the students have learned the underlying principles of theoretical numerical analysis.
2	Final Examination	70%	Final Examination questions are designed to see how far students have achieved their intended learning outcomes. Questions will primarily be understanding and skills based to assess the student's versatility in theoretical numerical analysis.

Learning Outcomes and Weighting:

Content	LO No.	Teaching (in hours)
I. Brief Introduction of Functional Analysis	1, 2, 10	6
II. Approximation Theory	3, 7, 10	7
III. Interpolation	4, 9, 10	6
IV. Numerical Integration	4, 8, 10	7
V. Sobolev Spaces	5, 9, 10	7
VI. Galerkin Method for PDEs	6, 10	7

Textbook: Lecture notes prepared by instructor.

References: K.E. Atkinson and Weimin Han, Theoretical numerical analysis : a functional analysis framework, Springer, 2001.
K.W. Morton, D.F. Mayers, Numerical Solution of Partial Differential Equations, Cambridge University Press, 2005.

Course Content in Outline:

	<u>Topic</u>	<u>Hours</u>
I.	Brief Introduction of Functional Analysis	6
	A. Linear Spaces, Norms	
	B. Banach Spaces and Hilbert Spaces	
	C. Mappings and Linear Operators	
	D. Linear Operators	
II.	Approximation Theory	7
	A. Convex Functional	
	B. The Best Approximation	
	C. Best Approximation in Inner Product Spaces	
	D. Orthogonal Polynomials	
	E. Best Approximation in MinMax	
III.	Interpolation	6
	A. Polynomial Interpolation	
	B. Piecewise Polynomial Interpolation	
IV.	Numerical Integration	7
	A. Interpolatory Quadrature Rules	
	B. Production Integration	
	C. Another Approach to Numerical Integration	
	D. The Euler-MacLaurin Formula	
V.	Sobolev Spaces	7
	A. Weak Derivatives	
	B. Sobolev Spaces	
	C. Interpolation and Approximation in Sobolev Spaces	
VI.	Galerkin Method for PDEs	7
	A. Bilinear Forms and Green's Formula	
	B. Galerkin Method	