Math3312: Numerical Analysis

Course outline - Fall 2024-2025

Instructor

Mo Mu

Contact Details: e-mail: mamu@ust.hk

Office Hour: Friday 11:50-12:20

Meeting Time and Venue

Monday 15:00 - 16:20, *Friday* 10:30-11:50, Zoom Online teaching, Sept 7-Dec 5, 202

Teaching Assistants

Fan Ganghua/gfanab T1A Mon 18:00-18:50

Fan Ganghua/gfanab T1B Tue 11:00-18:50

Course Description

Credit Points: 3

Pre-requisite: COMP 1002/COMP 1004 and MATH 2121/MATH 2111/MATH 2350/MATH 2131; and MATH 2033/MATH 2031/MATH 2043

Exclusion: MATH 3311

Brief Information/synopsis:

This course presents numerical methods for solving mathematical problems. It deals with the theory and application of numerical approximation techniques as well as their computer implementation. It covers computer arithmetic, solution

of nonlinear equations, interpolation and approximation, numerical integration and differentiation, solution of differential equations, and matrix computation.

Assessment Scheme

Homework: 10%; *Midterm Exam:* 30 %; *Final Exam:* 60 %

Final grades are determined based on the curve of total marks using a mixed relative and absolute scheme, with reference to the University general guidelines and with certain MINIMUM passing requirements to maintain the academic standards.

Exams:

Midterm Test:

Friday, Oct 23. Week 7, in class, Online via Zoom

If you *miss the midterm* due to a valid (e.g. hospitalization) and well proven reason (original documents must be submitted for verification), the only alternative is to move all the midterm marks to the final.

Form:

1. Closed books and notes. No formula sheets are provided.
2. Calculators approved by Hong Kong Examinations and Assessment Authority (香港考試及評核局) are allowed.
3. Use **5-(significant) digit rounding arithmetic** (see the exact definition in the textbook) in **major steps** of calculations.

Marks: 100

Topics to be tested in the midterm examination:

Root Finding (Chapter 2)

- Bisection method (2.1)
- Fixed-point iteration (2.2)

- Newton's method, Secant method (2.3)

Interpolation (Chapter 3)

- Interpolation and the Lagrange (interpolating) polynomial and the approximation error (3.1)
- Divided differences and Newton's interpolatory divided-difference formula (3.2)

Final Examination:

Time: (120 minutes),

Form:

1. Closed books and notes. No formula sheets are provided.
2. Calculators approved by Hong Kong Examinations and Assessment Authority (香港考試及評核局) are allowed.
3. Use **5-(significant) digit rounding arithmetic** (see the exact definition in the textbook) in **major steps** of calculations.

Marks: 100

Topics to be tested:

All materials taught in the whole semester will be tested, although including those already tested in the midterm test, however with focus on those not tested in the midterm test.

Student Learning Resources

Textbook:

Numerical Analysis (10th Ed), by Burden, R.L. and Faires J. D., Thomson Brooks/Cole.

References:

Math Support Center

Course Topics:

For details, see http://www.math.ust.hk/~mamu/courses/231/hom.htm

Preliminaries

- Roundoff Errors and Computer Arithmetic, Significant digits (1.2)
- Programming with Numerical Methods (e.g. Matlab)

Root Finding (Chapter 2)

- Bisection method (2.1)
- Fixed-point iteration (2.2)
- Newton's method, Secant method (2.3)

Interpolation (Chapter 3)

- Interpolation and the Lagrange (interpolating) polynomial and the approximation error (3.1)
- Divided differences and Newton's interpolatory divided-difference formula (3.2)

Numerical Differentiation and Integration (Chapter 4)

- Numerical differentiation--forward, backward, and central finite differences, errors (4.1)
- Elements of numerical integration (4.3)
- Composite rules (4.4)

Solution of Ordinary Differential Equations (Chapter 5)

- Euler's method and the approximation error (5.2)

Solving Linear Systems (Chapters 6 & 7)

- Gauss elimination--multipliers, Gauss elimination, back substitution, partial pivoting (6.1 - 6.2)
- LU factorization--LU, forward substitution (6.5)
- Iterative methods--matrix splitting, Jacobi method, Gauss-Seidel method, SOR method (7.3-7.4)

Teaching Approach

Lectures: focus on illustrating the concepts of the course content.

Tutorials: focus on examples and problem solving skills.

Intended Learning Outcomes

Upon successful completion of this course, students should know the following:

1. How to model and solve simple problems using first order odes;
2. How to solve linear, constant coefficient second-order odes;
3. How to use the Laplace transform method;
4. How to construct series solutions;
5. How to solve a system of linear, constant coefficient, first-order odes;
6. How to solve partial differential equations using separation of variables;

In addition, students should

7. Demonstrate skills in reading, interpreting and communicating mathematical content which are integrated into other disciplines or appear in everyday life;
8. Develop the mathematical maturity to undertake higher level studies in mathematically related fields.

Assessing Course ILOs:

Assignments and exams: 1, 2, 3, 4, 5, 6