HONG KONG BAPTIST UNIVERSITY
Faculty of Science

1. **Course Code and Course Title**
MATH 4665 Special Topics in Applied Mathematics I (3,3,0)

Sub-title: Advanced Numerical Methods & Algorithms

2. **No. of Units**
3

3. **Offering Department**
Department of Mathematics

4. **Pre-Requisite**
Year 3 standing or above or consent of instructor

5. **Co-Requisite / Anti-Requisite (if any)**
Nil

6. **Aims & Objectives**
The course aims to provide a general study to all students whose research fields are within the applied and computational mathematics. It covers some fundamental and important topics on linear algebra, optimization and partial differential equations. Real-world applications will be discussed, such as image processing, machine learning algorithms, financial modeling, climate models, and more.

7. **Course Intended Learning Outcomes (CILOs)**

CILO	By the end of the course, students should be able to:	PILO Alignment
1	Apply numerical techniques learned from the chosen topics to solve related open-ended problems	1
2	Suggest professional research proposal to solve real-life problems	1,3
3	Explain the concept/theory in a research professional and non-expert	3,4
4	Effectively communicate with others regarding research findings	3

8. **Teaching & Learning Activities (TLAs)**

CILOs	TLAs will include the following:
1,3	**Lecture** The instructor will present math applications to motivate students' interests and to introduce the topics of the course's materials. Basic concepts and algorithms will be introduced to consolidate students' background knowledge. Examples on numerical analysis will be given to illustrate finer details.

2,3,4	**In-class activities** During classes, students have the opportunity to participate in activities of various forms, including discussions and presentation. For example, students are asked to present their research proposals. Other students may be asked to evaluate and question the presented research ideas as referees.
1,2,3	**Student Orientated Case Study** Students work individually in a self-proposed research project and prepare a research article with publishable standard. They shall present the work to their classmates and take part in discussing and trying to improve others' work via exchange of ideas. This allows students to develop their collaboration and communication skills.

9 **Assessment Methods (AMs)**

Type of Assessment Methods	Weighting	CILOs to be Address	Description of Assessment Tasks
Written Assignments	30%	1	High-level questions, including open-ended problems and black box explorations in each chapter will be given. There will be at least 3 assignments. Each of them allows the instructor to keep track of how well the students master the math concept, computational skill, and numerical and analytical techniques covered during different stages of the course.
Oral assessment	20%	2,3	Possible research directions will be given, and students are required to propose and present their own research proposal verbally without doing calculation. There will be 2 oral assessments. Each of them allows the students to know what they understand well and what they need to think more about in order to prepare a professional research proposal. It also allows the instructor to correct students' misconception and identify learning needs.

Project	25%	3	Students work individually on the endorsed research proposal. The project allows the instructor to assess how well students perform in the following criteria. • 20% organization and motivation to sell the key points of the paper • 20% selecting good notation and giving appropriate amounts of details • 20% describe and analyze numerical results accurately • 20% Work readiness for submission Professional typesetting in LaTeX is strongly recommended.
Presentation	25%	3,4	Students will submit a poster presentation in a conference setting, and they are also required to take part in discussing and trying to improve others' projects/ multi-media presentation via exchange of ideas. The presentation allows the instructor to assess how well students perform in the following criteria. • 20% clarity and effectiveness of poster • 40% audibility and liveliness of the presentation • 20% accuracy of mathematical content in Q&A • 20% ability to comment and give good suggestions to others' projects

10. **Assessment Rubrics**

To be determined by the instructor

11. **Course Intended Learning Outcomes and Weighting**

Content	CILO No.	Teaching (in hours)
I. Linear Algebra	1,3	13
II. Optimization	2,3,4	13
III. Partial Differential Equations	2,3,4	13

12. **Textbooks / Recommended Remarks**

References

1. Applied Numerical Linear Algebra by James W. Demmel

2. J. E. Dennis, Jr. and R. B. Schnabel, Numerical Methods for Unconstrained Optimization and Nonlinear Equations, SIAM, 1996.
3. D. G. Luenberger, Linear and Nonlinear Programming, 2nd edition, Addison-Wesley, 1984.
4. Lawrence C. Evans, Partial Differential Equations, American Mathematical Society, 1997.

Software

1. Matlab and other related matrix computation software

13. **Course Content**

	Topics	Hours
I	Linear Algebra	13
	A Iterative Methods for Linear Systems	
	B Iterative Methods for Eigenvalue Problems	
II	Optimization	13
	A Multivariable Calculus Background	
	B Optimality Condition	
	C Newton's Method for Unconstrained Optimization	
	D Globally Convergent Modifications of Newton's Method	
	E Quasi-Newton Methods (optional, depends on the time)	
III	Partial Differential Equations	13
	A Overview	
	B Laplace's Equation	
	C Heat Equation	
	D Wave Equation	
	E Numerical Methods (optional, depends on the time)	

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Approved by Faculty Board meeting on 17 May 2023.

Approved by Faculty Board via circulation on 30 August 2024.