City University of Hong Kong
Course Syllabus

offered by College/School/Department of _Mathematics_____
with effect from Semester __A____ 20_20_ / _21_

Part I Course Overview

Course Title:	**Introduction to Functional Analysis**
Course Code:	**MA4551**
Course Duration:	**1 semester**
Credit Units:	**3**
Level:	**B4**
Proposed Area: *(for GE courses only)*	☐ **Arts and Humanities** ☐ **Study of Societies, Social and Business Organisations** ☐ **Science and Technology**
Medium of Instruction:	**English**
Medium of Assessment:	**English**
Prerequisites: *(Course Code and Title)*	**MA2503 Linear Algebra / MA1503 Linear Algebra with Applications, and MA3524 Analysis / MA3526 Analysis**
Precursors: *(Course Code and Title)*	**Nil**
Equivalent Courses: *(Course Code and Title)*	**Nil**
Exclusive Courses: *(Course Code and Title)*	**Nil**

Part II Course Details

1. Abstract

(A 150-word description about the course)

As a branch of mathematical analysis, functional analysis brought with it a change of focus from the study of functions on the Euclid space to the analysis of abstract infinite-dimensional spaces, for example, Banach spaces and Hilbert spaces. As such it established a key framework for the development of modern analysis, and is particularly useful for the study of differential and integral equations.

This elective course will introduce the basic concepts of the functional analysis, such as the normed linear space, duality, weak convergence, and the Hilbert space. The basic knowledge of linear algebra and elementary analysis is required. The course will also discuss several fundamental and important theorems, for example, the Hahn-Banach theorem, the Riesz-Frechet representation theorem, and the fixed point theorems. These topics present the basic structure of this subject, and loom large in the body of mathematics. Finally, there will be a careful balance between the theories and the applications. The students, who complete this course, are expected to be prepared for the advanced Math courses at the graduate level and for the modern development of the research in the analysis.

2. Course Intended Learning Outcomes (CILOs)

(CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)

No.	CILOs[#]	Weighting* (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	Introduce the normed linear space and the Hahn-Banach theorem.	10%		✓	
2.	Introduce the bounded linear functionals, the applications of duality, and the weak convergence	30%		✓	
3.	Introduce the Hilbert space, the Riesz-Frechet representation theorem, the Lax-Milgram lemma, and applications	30%	✓	✓	
4.	Fixed point theorems, and solve the problems arising from the analysis	30%	✓	✓	✓
	** If weighting is assigned to CILOs, they should add up to 100%.*	100%			

[#] Please specify the alignment of CILOs to the Gateway Education Programme Intended Learning outcomes (PILOs) in Section A of Annex.

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to self-life problems.

A3: *Accomplishments*
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

3. Teaching and Learning Activities (TLAs)

(TLAs designed to facilitate students' achievement of the CILOs.)

TLA	Brief Description	CILO No.						Hours/week (if applicable)
		1	2	3	4			
Lectures	Learning through **teaching** is primarily based on lectures	✓	✓	✓	✓			39 hours in total
Assignment	Learning through **assignments** helps students understand basic concepts and several fundamental and important theorems in the functional analysis.	✓	✓	✓	✓			After-class

4. Assessment Tasks/Activities (ATs)

(ATs are designed to assess how well the students achieve the CILOs.)

40% Coursework
60% Examination (Duration: 2 hours, at the end of the semester)

For a student to pass the course, at least 30% of the maximum mark for the examination must be obtained.

Assessment Tasks/Activities	CILO No.						Weighting*	Remarks
	1	2	3	4				
Continuous Assessment: __40__%								
Test	✓	✓	✓				20%	
Hand-in assignments (3 or above)	✓	✓	✓	✓			20%	
Examination: _60___% (duration:2 hrs, if applicable)								
** The weightings should add up to 100%.*							100%	

5. Assessment Rubrics

(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Test	Ability in problem solving	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Assignments	Understanding of concepts and applications	High	Significant	Moderate	Basic	Not even reaching marginal levels
3. Examination	Comprehensive ability in independent problem solving	High	Significant	Moderate	Basic	Not even reaching marginal levels
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Part III Other Information (more details can be provided separately in the teaching plan)

1. Keyword Syllabus

(An indication of the key topics of the course.)

Normed linear space, duality, weak convergence, Hilbert space, the Hahn-Banach theorem, the Riesz-Frechet representation theorem, and the fixed point theorem

2. Reading List

2.1 Compulsory Readings

(Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)

1.	Lecture notes distributed in class
2.	
3.	
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2.2 Additional Readings

(Additional references for students to learn to expand their knowledge about the subject.)

1.	Lax, P.: *Functional Analysis*, Wiley-Interscience, 2002
2.	Yosida, K., *Functional Analysis*, Springer-Verlag, 6th edition, 1980
3.	Conway, J. B.: *A Course in Functional Analysis*, 2nd edition, Springer-Verlag, 1994
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