Annexe A: New/Revised Course Content in OBTL+ Format

Course Overview

Expected Implementation in Academic Year	AY2019-2020
Semester/Trimester/Others (specify approx. Start/End date)	Semester 2
Course Author * Faculty proposing/revising the course	Tang Wee Kee
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Course Title	REAL ANALYSIS II
Course Code	MH4100
Academic Units	4
Contact Hours	51
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	{MH2100, MH3100} OR {CY1602, MH3100} OR {MH1803, MH3100}
Co-requisites	
Pre-requisite to	
Mutually exclusive to	
Replacement course to	
Remarks (if any)	

Course Aims

This is the second of two courses on Real Analysis. The course aims to present a rigorous treatment of the principal topics of real analysis, such as Lebesgue measure, Lebesgue integrals, differentiation, convexity, and normed linear spaces, and to illustrate the power of the subject through a variety of applications. After learning this course, you will be able to make connections between the abstract settings and the concrete problems studied in various courses in calculus and probability theory.

Course's Intended Learning Outcomes (ILOs)

Upon the successful completion of this course, you (student) would be able to:

ILO 1	Determine the liminf and limsup of a sequence of extended real numbers;
ILO 2	Determine the set of points of continuity of a given function (as a Borel set);
ILO 3	Determine if a function is measurable;
ILO 4	Compute the Lebesgue Integral of a given funtion;
ILO 5	Compute the limit of the integral if a sequence of functions by using various limit theorems like Fatou Lemma, and Lebesgue Dominated Convergence Theorem;
ILO 6	Prove major convergence theorems by using Fatou's Lemma;
ILO 7	Establish relationship between differentiation and integration, in terms of bounded variations and absolute continuity;
ILO 8	Apply Jensen inequality for convex functions;
ILO 9	Prove Holder and Minkowski inequalities for Lp spaces;
ILO 10	Prove Lp spaces are complete;
ILO 11	Prove Riesz Representation Theorem for Lp spaces.

Course Content

Basic topology on the real line and extended real line Measurable sets and measurable functions Lebesgue integration Differentiation, bounded variation, absolute continuity, and convex functions Classical Banach spaces

Reading and References (if applicable)

H. L. Royden, Real Analysis, 3rd Edition, MacMillan Publishing Company, ISBN-10:0024041513

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	Basic topology on the real line and extended real line	1,2,3		In-person	
2	Open Sets Closed Sets	1,2		In-person	
3	Continuous Functions	3,6		In-person	
4	Measurable sets	3,5		In-person	
5	Measurable functions	3,10		In-person	
6	Lebesgue integration	4,5		In-person	
7	Lebesgue integration (continued)	4,5,6		In-person	
8	Convergence Theorems	4,5,6		In-person	
9	Differentiation	7,8		In-person	
10	Functions of bounded variation, absolute continuity	7,8		In-person	
11	Convex Functions	7,8		In-person	
12	Classical Banach spaces	9,10,11		In-person	
13	Classical Banach spaces	9,10,11		In-person	

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Lectures	Examples and Explanation: Motivations of the concepts given in the learning objectives 1-11 will be provided through examples. The general theory and principles are then explained. This also introduces more abstract mathematical reasonings.
Tutorials	Problem Solving: Develops competence in solving a variety of problems in and gaining familiarity with mathematical proofs.

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Description of Assessment Component	Team/Individual	Rubrics	Level of Understanding
1	Continuous Assessment (CA): Assignment()	1, 2, 3, 4, 5, 6, 7, 8, 9	1. a,b,c, 2.a,b,c,d, 3.a, 4.a, 5.a	20		Individual	Analytic	Extended Abstract
2	Continuous Assessment (CA): Test/Quiz(Mid Term Test)	1, 2, 3, 4, 5, 6, 7, 8, 9	1. a,b,c, 2.c, 3.a, 5.a	20		Individual	Analytic	Extended Abstract
3	Summative Assessment (EXAM): Final exam()	1, 2, 3, 4, 5, 6, 7,8, 9, 10, 11	1.a,b, 2.a,b, 3.a, 5.a	60		Individual	Analytic	Extended Abstract

Description of Assessment Components (if applicable)

Formative Feedback

Feedback will be given to you through the weekly problem tutorial sets that are covered in tutorial.

Common misunderstanding of major concepts will also be discussed in lecture.

Common mistakes in the midterm tests will be discussed in the provided solution sets.

NTU Graduate Attributes/Competency Mapping

This course intends to develop the following graduate attributes and competencies (maximum 5 most relevant)

Attributes/Competency	Level
Adaptability	Advanced
Communication	Advanced
Creative Thinking	Advanced
Curiosity	Advanced
Problem Solving	Advanced

Course Policy

Policy (Academic Integrity)

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values. As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. On the use of technological tools (such as Generative AI tools), different courses / assignments have different intended learning outcomes. Students should refer to the specific assignment instructions on their use and requirements and/or consult your instructors on how you can use these tools to help your learning. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Policy (General)

Policy (Absenteeism)

Policy (Others, if applicable)

Diversity and inclusion policy

Integrating a diverse set of experiences is important for a more comprehensive understanding of science.

It is our goal to create an inclusive and collaborative learning environment that supports a diversity of perspectives and learning experiences, and that honours your identities; including ethnicity, gender, socioeconomic status, sexual orientation, religion or ability.

To help accomplish this:
- If you are neuroatypical or neurodiverse, have dyslexia or ADHD (for example), or have a social anxiety disorder or social phobia;
- If you feel like your performance in the class is being impacted by your experiences outside of class;
- If something was said in class (by anyone, including the instructor) that made you feel uncomfortable;

Please speak to your teaching team, our school pastoral officer or a peer or senior (either in-person or via email) about how we can help facilitate your learning experience.

As a participant in course discussions, you should also strive to honour the diversity of your classmates. You can do this by: using preferred pronouns and names; being respectful of others opinions and actively making sure all voices are being heard; and refraining from the use of derogatory or demeaning speech or actions.

All members of the class are expected to adhere to the NTU anti-harassment policy. if you witness something that goes against this or have any other concerns, please speak to your instructors or a faculty member.

This course aims to develop deep mathematical insights through abstract and rigorous treatment of analysis. The process of establishing the results is more important than the result statements It is therefore essential to attend all lectures.

To gain a better understanding, you need to attempt all tutorial problems instead of waiting for answers to be given. The solutions obtained by you through the necessary struggles will be internalized and this process will help you handle future unfamiliar problems.