Course Syllabus

offered by Department of Mathematics
with effect from Semester A 2022/23

Part I Course Overview

Course Title:	Topics in Applied and Computational Harmonic Analysis
Course Code:	MA8021
Course Duration:	One semester
Credit Units:	3
Level:	R8
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites: *(Course Code and Title)*	Nil
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

This course aims to help research students developing a solid and systematic training in theory of classical and modern harmonic analysis. It also explores frontier areas in applied and computational harmonic analysis and its applications in high-dimensional data analysis and machine learning.

2. Course Intended Learning Outcomes (CILOs)

No.	CILOs[#]	Weighting* (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	explain the fundamentals in the theory of harmonic analysis	20%	✓		
2.	develop a solid and systematic understanding of multiresolution analysis and framelets	30%	✓	✓	
3.	explore the cutting-edge development of applied and computational harmonic analysis	30%	✓	✓	
4.	implement a number of stat-of-the-art fast framelet transforms	10%		✓	✓
5.	apply harmonic analysis technique to a variety of high-dimensional data applications	10%	✓	✓	✓
		100%			

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)

TLA	Brief Description	CILO No.						Hours/week (if applicable)
		1	2	3	4	5		
Lectures	Learning through teaching is primarily based on lectures	✓	✓	✓	✓	✓		3 hrs/wk
Assignments	Learning through take-home assignments helps students understand basic mathematical concepts and fundamental theory of linear algebra, and develop the ability of proving mathematical statements rigorously.		✓		✓	✓		After-class
Final project	Learning through final projects helps students explore cutting-edge development of the current research in applied harmonic analysis	✓	✓	✓	✓	✓		After-class

4. Assessment Tasks/Activities (ATs)

Assessment Tasks/Activities	CILO No.						Weighting*	Remarks
	1	2	3	4	5			
Continuous Assessment: 70%								
Hand-in assignments		✓		✓	✓		30%	These are skills based assessment to enable students to demonstrate the basic concepts and fundamental theory of statistical machine learning.
Final project presentation	✓	✓	✓	✓	✓		40%	Final project presentation provides students chances to demonstrate their exploration and understanding of the cutting-edge development of the current research in statistical machine learning
Examination: 30% (duration: 2 hours)	✓	✓	✓	✓	✓		30%	Examination questions are designed to see how far students have achieved their intended learning outcomes. Questions will primarily be skills and understanding based to assess the student's versatility in statistical machine learning.
							100%	

5. Assessment Rubrics

Applicable to students admitted in Semester A 2022/23 and thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B)	Marginal (B-,C+,C)	Failure (F)
1. Hand-in assignments	DEMONSTRATION of the understanding of the basic materials	High	Significant	Basic	Not even reaching marginal levels
2. Final project presentation	DEMONSTRATION of the exploration and understanding of the modern research	High	Significant	Basic	Not even reaching marginal levels
3. Examination	DEMONSTRATION of skills and versatility in applied harmonic analysis	High	Significant	Basic	Not even reaching marginal levels

Applicable to students admitted before Semester A 2022/23

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Hand-in assignments	DEMONSTRATION of the understanding of the basic materials	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Final project presentation	DEMONSTRATION of the exploration and understanding of the modern research	High	Significant	Moderate	Basic	Not even reaching marginal levels
3. Examination	DEMONSTRATION of skills and versatility in applied harmonic analysis	High	Significant	Moderate	Basic	Not even reaching marginal levels

Part III Other Information (more details can be provided separately in the teaching plan)

1. Keyword Syllabus

Fourier Transform and Distributions; Function Spaces and Atomic Decomposition; Multiresolution Analysis and Framelets; Framelets on Manifolds and Graphs; Harmonic Analysis in Machine Learning.

2. Reading List

2.1 Compulsory Readings

1.	Modern Fourier Analysis, 2nd Edition, Loukas Grafakos, Springer 2009
2.	Ten Lectures on Wavelets, Ingrid Daubechies, SIAM 1992

2.2 Additional Readings

Harmonic Analysis, Elias M. Stein, Princeton University Press, 1993