MCS New Course Proposal Form

Course Title: Applied Harmonic Analysis

Instructors: Click here to enter text.

Course Number: 21-435 Cross Listing: Click here to enter text.

Prerequisites/Corequisites: 21-355 (or 21-235) and 21-241 (or 21-242).

Semesters Offered:

☐ Fall  ☑ Spring  ☐ Summer-All  ☐ Summer 1  ☐ Summer 2

Semester Length:

☐ Mini 1  ☐ Mini 2  ☐ Mini 3  ☐ Mini 4  ☑ Full Semester

Course Offering Frequency: Every other year

Suggested Days and Times: M-W-F

Course Evaluation type:  ☑ Letter Grade  ☐ Pass/Fail

Course Unit Justification:  Total Units 9.

In Class Hours: 3.  Recitation Hours: N/A.

Lab Hours: N/A.  Out of Class Hours: 6.

Target Population: Juniors and seniors in math, computer science, and engineering.

Anticipated Enrollment: 20.

Rationale for Course (Background): The goal of the proposed course is to expose students to a number of important topics in harmonic analysis and its applications, including signal processing and image processing. While it is meant to be one of the core courses in the Computational and Applied Mathematics Concentration, it will be accessible to undergraduate students in mathematics, engineering, and the applied sciences.

Special Facilities Needed: None.
Textbooks and/or Other Materials: None

Assessment: Two exams: one midterm and one final. Weekly homework.

Topics Covered: Discrete Fourier transform and fast Fourier transform
Fourier series and the Fourier transform
Hilbert spaces and applications
Shannon sampling theorem, bandlimited functions, uncertainty principle
Wavelets and multi-resolution analysis
Applications in image processing

Course Catalog Description: This course serves as a broad introduction to harmonic analysis and its applications, particularly in 1-dimensional signal processing and in image processing, for undergraduate students in mathematics, engineering, and the applied sciences. Topics include: Discrete Fourier transform and fast Fourier transform; Fourier series and the Fourier transform; Hilbert spaces and applications; Shannon sampling theorem, bandlimited functions, uncertainty principle; Wavelets and multi-resolution analysis; Applications in image processing.

Learning Objectives: This course serves as a broad introduction to harmonic analysis and its applications. At the end of the course, students should be able to

- to state and prove the principal theorems of basic harmonic analysis
- to apply these principal results to various practical applications in signal processing
- to be able to read and write proofs.

Departmental Approval Date: Click here to enter text.

CUA Recommendation Date: Click here to enter text.

College Council Approval Date: Click here to enter text.

Date Sent to Enrollment Services: Click here to enter text.

Comments: Click here to enter text.

☐ Please attach a copy of the proposed syllabus
Course Description

*Prerequisites:* 21-241 Matrices and Linear Transformations or 21-242 Matrix Theory; 21-355 Principal of Real Analysis I or 21-235 Math Studies: Analysis I

*Units:* 9

*Syllabus:* This course serves as a broad introduction to harmonic analysis and its applications, particularly in 1-dimensional signal processing and in image processing, for undergraduate students in mathematics, engineering, and the applied sciences. Topics covered include

- Discrete Fourier transform and fast Fourier transform
- Fourier series and the Fourier transform
- Hilbert spaces and applications
- Shannon sampling theorem, bandlimited functions, uncertainty principle
- Wavelets and multi-resolution analysis
- Applications in image processing

*Course Objectives:*

1. to learn the principal theorems of basic harmonic analysis,

2. to apply these principal results to various practical applications in signal processing,

3. to further enhance a student’s mathematical maturity with reading and writing proofs.

*Evaluation:* (The following can vary from instructor to instructor).

1. Two exams: one midterm and one final

2. Weekly homework

*Academic Integrity:* All CMU academic integrity policies apply to this class. Please look through https://www.cmu.edu/academic-integrity/.

*Take care of yourself.* Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress.

All of us benefit from support during times of struggle. You are not alone. There are many helpful resources available on campus and an important part of the college
experience is learning how to ask for help. Asking for support sooner rather than later is often helpful.

If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. Counseling and Psychological Services (CaPS) is here to help: call 412-268-2922 and visit their website at http://www.cmu.edu/counseling/. Consider reaching out to a friend, faculty or family member you trust for help getting connected to the support that can help.