MATHEMATICS
COLLEGE OF ARTS AND SCIENCES

SUMMER RESEARCH OPPORTUNITIES FOR UNDERGRADUATE students

FOR APPLICATION YEAR: 2022

PROJECT TITLE: Algorithms for Computing Highly Oscillatory Integrals

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Project Description

Recently new methods for computing highly oscillatory integrals have been discovered. The fundamental ideas revolve around Taylor series, integration by parts, coding, and a concept known as shifting stationary points. The goal of the project is to compute these integrals in the form of a non-oscillatory function multiplied by an oscillation such as the sine function to arbitrary accuracy via accessible manipulations. Highly oscillatory integrals show up in a variety of fields of mathematics, physics, and engineering, including Fourier series, partial differential equations, plasma physics, wave propagation, imaging analysis (MRI's and X-rays), and much more. This research project strikes a rare balance of being accessible to any undergrad that has finished the first two semesters of calculus, while also offering the potential to produce publishable results.

The student will be tasked with coding in their choice of Matlab, Python, or C++, as well as researching and developing new techniques for computing these oscillatory integrals. The only requirements for this project are completion of the first two semesters of Calculus. All training in coding can be learned over the course of the project. The student will also learn, if not already familiar with, the programming language Mathematica.

The research mentor will provide the following
1) Software needed to write these algorithms.
2) Training in relevant software.
3) Training and expertise in the field of highly oscillatory integrals.
4) Guidance on how to present research in the form of papers, poster talks, or seminar talks.
5) Should the student be interested, continued research in the following academic year.