MCS New Course Proposal Form

Course Title: Numerical Methods II: Scientific Computing

Instructors: Click here to enter text.

Course Number: 21-469. Cross Listing: Click here to enter text.

Prerequisites/Corequisites: 21-355 (or 21-235) and 21-260 (or 21-261) and 21-241 (or 21-242) and 21-272 and 21-369.

Semesters Offered:

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

Semester Length:

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

Course Offering Frequency: Every other year

Suggested Days and Times: M-W-F

Course Evaluation type: X 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 fundamental techniques in scientific computing and advanced numerical methods. 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 other disciplines with a strong background in mathematics.

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

Assessment: Problem Sets will be given weekly. There will be a total of about 12 Problem Sets. The Problem Sets consist of both theoretical (pen-and-paper) and computational work. The computational work can be completed using MATLAB or other languages (C++, Python, etc). Exams: There will be one midterm and one final exam. In addition, one final coding problem to turn-in during the final week of classes.

Topics Covered:

Numerical Methods for Dynamical Systems
Numerical Methods for Linear Partial Differential Equations
Computational Linear Algebra
Data Fitting and Approximation
Computational Methods for Nonlinear Problems

Course Catalog Description: This course is the continuation for 21-369 and is centered on the mathematics of scientific computing and advanced numerical methods. The focus of this course is on numerical methods for partial differential equations, with an emphasis on computing and applications. This course is intended for undergraduate students in mathematics, engineering, and the applied sciences.

Topics will include: Numerical Methods for Dynamical Systems; Numerical Methods for Linear Partial Differential Equations; Computational Linear Algebra; Data Fitting and Approximation; Computational Methods for Nonlinear Problems.

Learning Objectives: This course is a general introduction to numerical methods which will be covered from both the theoretical and computational perspectives. By the end of the course, students should be able to computationally solve a variety of mathematical problems related to partial differential equations and nonlinear sciences. In particular, students should be able:

- To develop and/or identify appropriate numerical methods to approximate solutions to various problems
- To construct a practical pseudo-code and to implement it on a computer
- To analyze the numerical method and to provide theoretical guarantees to its behavior

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; 21-260 Differential Equations or 21-261 Introduction to Ordinary Differential Equations or 33-231 Physical Analysis; 21-355 Principal of Real Analysis I or 21-235 Math Studies: Analysis I; 21-272 Introduction to Partial Differential Equations; 21-369, numerical methods I

Units: 9

Syllabus:
This course is the continuation for 21-369 and is centered on the mathematics of scientific computing and advanced numerical methods. The focus of this course is on numerical methods for partial differential equations, with an emphasis on computing and applications. This course is intended for undergraduate students in mathematics, engineering, and the applied sciences. Topics covered include

- Numerical Methods for Dynamical Systems
- Numerical Methods for Linear Partial Differential Equations
- Computational Linear Algebra
- Data Fitting and Approximation
- Computational Methods for Nonlinear Problems

Course Objectives: This course is a general introduction to numerical methods which will be covered from both the theoretical and computational perspectives. By the end of the course, you should be able to computationally solve a variety of mathematical problems related to partial differential equations and nonlinear sciences. In particular, you should be able:

- To develop and/or identify appropriate numerical methods to approximate solutions to various problems
- To construct a practical pseudo-code and to implement it on a computer
- To analyze the numerical method and to provide theoretical guarantees to its behavior

Evaluation: (The following can vary from instructor to instructor). Problem Sets will be given weekly. There will be a total of about 12 Problem Sets. The Problem Sets consist of both theoretical (pen-and-paper) and computational work. The computational work can be completed using MATLAB (see http://www.cmu.edu/computing/software/all/matlab/) or other languages (C++,...
Python, etc). You can work in groups, but the assignments should be completed individually and all work must be shown. To receive full credit on the Problem Sets, you must attach the relevant code as well as the outputs of your code. Late homework will not be accepted.

Exams: You will have one midterm and one final exam. In addition, you will have one final coding problem to turn-in during the final week of classes.

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

**Learning Accommodations:** Let me know at the beginning of the term if you anticipate the need for any learning accommodations. Please see http://www.cmu.edu/hr/eos/disability/index.html for more information.

**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.