# Michigan Technological University
**1885**

## PH4390 Computational Methods in Physics

Syllabus

Fall 2017

## Instructor Information

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|---|---|
| Instructor: | Kevin Waters |
| Office Location: | Fisher 227A |
| E-mail: | kwaters@mtu.edu |
| Office Hours: | T/TH 11:00 - 12:00 or by appointment |

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| Instructor: | Ravindra Pandey |
| Office Location: | Fisher 108 |
| Telephone: | 906-487-2086 |
| E-mail: | pandey@mtu.edu |
| Office Hours: | by appointment |

## Course Identification

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|---|---|
| Course Number: | PH4390 |
| Course Name: | Computational Methods in Physics |
| Course Location: | T/TH Fisher 132, F Rehki 117 |
| Class Times: | T/TH 10:05am - 10:55am, F 9:05am - 10:55am |
| Prerequisites: | PH 2020 Introduction to Scientific Programming and Error Analysis |
| | PH 3410 Quantum Physics I |

## Course Description/Overview

An overview of numerical and computational methods to analyze and visualize physics problems in mechanics, electromagnetism, and quantum mechanics. Utility and potential pitfalls of these methods, basic concepts of programming, UNIX computing environment, and system libraries.

# Learning Objectives

† Gain an understanding of the basics of writing and executing useful code.

† Learn the fundamentals of the Unix/Linux environment.

† Author software that allows the student to solve physical problems.

† Write reports using theory and numerically generated data to analyze and solve complex problems.

# Course Resources

† Canvas: https://mtu.instructure.com/

† Required Text: No required text for this course.

# Grading Scheme

## Total Points

Assignments = 10 x 10 Points each = 100 Points

Project = 30 Points

Total = 130 Points

**Grading System**

| Grade | Percentage | Points |
|-------|------------|--------|
| A | 93% - 100% | 121-130 |
| AB | 87% - 92% | 113-120 |
| B | 82% - 86% | 106-112 |
| BC | 76% - 81% | 99-105 |
| C | 70% - 75% | 91-98 |
| CD | 65% - 69% | 84-90 |
| D | 60% - 64% | 78-83 |
| F | 59% - 0% | 0-77 |

## Grading Rubric for Assignments

| Section | Breakdown | Points | Description |
|---|---|---|---|
| Code | Compiles | 1 | Code compiles successfully. |
| | Documentation | 1 | Code is commented and clear. |
| | Readme | 1 | Readme describes compilation and run procedure. |
| | Functionality | 1 | Code produces a reasonable solution. |
| Report | Discussion | 1 | Approximations used are discussed, description of theory. |
| | Equations | 1 | Equations are provided and descriptions provided. |
| | Data Presentation | 1 | Data has descriptions and is labeled with units. |
| | Report Clarity | 1 | Report is organized and clear. |
| | Questions | 2 | Questions are answered correctly with an explanation. |
| | **Total** | **10** | |

## Grading Rubric for Project

| Section | Breakdown | Points | Description |
|---|---|---|---|
| Code | Compiles | 2 | Code compiles successfully. |
| | Documentation | 2 | Code is commented and clear. |
| | Readme | 2 | Readme describes compilation and run procedure. |
| | Functionality | 2 | Code produces a reasonable solution. |
| Report | Discussion | 2 | Approximations used are discussed, description of theory. |
| | Equations | 2 | Equations are provided and descriptions provided. |
| | Data Presentation | 2 | Data has descriptions and is labeled with units. |
| | Report Clarity | 2 | Report is organized and clear. |
| | Questions | 4 | Questions are answered correctly with an explanation |
| Presentation | | 10 | |
| | **Total** | **30** | |

## Late Assignment Policy

No late assignments will be accepted, if problems arise please contact the instructor.

# Collaboration/Plagiarism Rules

Collaboration is encouraged in this course, however, work will be turned in independently and cited properly. At the end of each assignment use the references section to cite all books, web resources, student collaborations, and any other outside source you make have used.

# University Policies

For more information about reasonable accommodation for equal access to education or services at Michigan Tech, please call the Dean of Students Office, at (906) 487- 2212 or go to
http://www.mtu.edu/ctl/instructional-resources/syllabus/syllabus_policies.html

# Course Schedule

| Week | Date | Day | Type | Description |
|------|------|-----|------|-------------|
| Week 1 | 9/5 | T | Lecture | Introduction and Syllabus Review |
| | 9/7 | Th | Lecture | The C Programming Language |
| | 9/8 | F | **No Class** | K-Day |
| Week 2 | 9/12 | T | Lecture | Types, Operators, Expressions |
| | 9/14 | Th | Lecture | Functions and Structures |
| | 9/15 | F | Lab | Assignment 1: Error Analysis |
| Week 3 | 9/19 | T | Lecture | Convergence, Precision, Accuracy |
| | 9/21 | Th | Lecture | Plotting Data (gnuplot) |
| | 9/22 | F | **No Class** | Assignment 2: Plotting Data and Errors |
| | | | | **Assignment 1: Due by 8:59am** |
| Week 4 | 9/26 | T | Lecture | Modular Programming: Divide and Conquer |
| | 9/28 | Th | Lecture | Makefiles: Compiling with Ease |
| | 9/29 | F | Lab | Assignment 3: Series and Truncations |
| | | | | **Assignment 2: Due by 8:59am** |
| Week 5 | 10/3 | T | Lecture | Random Numbers |
| | 10/5 | Th | Lecture | Monte Carlo Methods |
| | 10/6 | F | Lab | Assignment 4: $\pi$ at Monte Carlo |
| | | | | **Assignment 3: Due by 8:59am** |
| Week 6 | 10/10 | T | Lecture | Roots: Successive Bisection Method |
| | 10/12 | Th | Lecture | Roots: Newtown-Raphson & Hybrid |
| | 10/13 | F | Lab | Assignment 5: Finding Roots |
| | | | | **Assignment 4: Due by 8:59am** |
| Week 7 | 10/17 | T | Lecture | Integration: Simpson's/Trapezoid Rule |
| | 10/19 | Th | Lecture | GSL Libraries |
| | 10/20 | F | Lab | Assignment 6: Electrons and Wavefunctions |
| | | | | **Assignment 5: Due by 8:59am** |
| Week 8 | 10/24 | T | Lecture | Differential Equations: Euler |
| | 10/26 | Th | Lecture | Differential Equations: RK4 |
| | 10/27 | F | Lab | Assignment 7: Projectile Motion |
| | | | | **Assignment 6: Due by 8:59am** |

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| Week 9 | 10/31 | T | Lecture | Matrices: Computational Linear Algebra |
| | 11/2 | Th | Lecture | Matrices: Libraries |
| | 11/3 | F | Lab | Assignment 8: 2-D Drag |
| | | | | **Assignment 7: Due by 8:59am** |
| Week 10 | 11/7 | T | Lecture | Unit Tests: Checking with Ease |
| | 11/9 | Th | Lecture | Unit Tests: Part Two |
| | 11/10 | F | Lab | Assignment 9: Unit Test Generation |
| | | | | **Assignment 8: Due by 8:59am** |
| Week 11 | 11/14 | T | Lecture | Final Project Overview Part I |
| | 11/16 | Th | Lecture | Final Project Overview Part II |
| | 11/17 | F | **No Class** | |
| | | | | **Assignment 9: Due by 8:59am** |
| Week 13 | 11/21 | T | **No Class** | Thanksgiving Break |
| | 11/23 | Th | **No Class** | Thanksgiving Break |
| | 11/24 | F | **No Class** | Thanksgiving Break |
| Week 12 | 11/28 | T | Lecture | TBD |
| | 11/30 | Th | Lecture | TBD |
| | 12/1 | F | Lab | Make-Up Session |
| | | | | **Project Update: Due by 8:59am** |
| Week 14 | 12/5 | T | Lecture | TBD |
| | 12/7 | Th | Lecture | TBD |
| | 12/8 | F | Lab | Final Project I |
| Week 15 | 12/12 | T | Lecture | Optional: Project Questions |
| | 12/14 | Th | Lecture | Optional: Project Questions |
| | 12/15 | F | Lab | Final Project II |
| Week 16 | 12/19 | T | Final Exam | Final Project Presentations |