M415 SYLLABUS

Instructor:	Jim Carter	Office:	KO/048 A
Office phone:	765-455-9267	Hours:	TH 11:40a (or appt)
Email:	carter42@iu.edu	Class meetings:	TH 1:00p-2:15p KO/052

Course description

Topics to be covered include multivariable functions, complex arithmetic, the Cauchy-Riemann equations, complex functions, complex integration, complex differentiation, and analytic functions and their properties.

Prerequisites. M413. Recommended M311.

Learning Objectives. This course contributes to the fulfillment of the following goals for a degree in mathematics:

- Understand the nature of truth and the concept of proof in the discipline of mathematics
- Formulate and solve problems mathematically
- Communicate mathematical ideas clearly and effectively

For more details, see Learning Outcomes.

Text. *Complex Variables, Harmonic and Analytic Functions*, 1st ed. by Francis J. Flanigan.

Grading

Attendance. Regular attendance is crucial to success in any mathematics course. All students are responsible for all material presented in class; attendance will be taken every class.

Homework. Homework will completed on paper and uploaded to Canvas. Most exercises will come from the book however some supplemental problems may be posted on Canvas. To be successful in this course it is very important to set aside enough time for private study (a minimum of six hours each week). Most learning will take place when you do these exercises so it is very important to keep up to date with this work and to take care to write your solutions clearly and neatly in a designated notebook or binder. Your solutions to the homework exercises should be considered part of your course notes. These exercises may be discussed in class. **Remember that Mathematics is not a spectator sport.**

Homework in this course will be significantly different from previous mathematics courses. On each homework assignment, you may (at the instructor's discretion) be allowed to revise and resubmit up to 1 problem (selected by the instructor). Revisions will not be posted on Canvas as separate assignments and will be due 1 week after the homework due date.

Exams. There will be 2 exams given this semester. The midterm exams combined will be worth 20% of your final grade and the final exam will be worth 20% of your final grade.

Exam Make-Up Policy. If you know that you cannot attend class when an exam is scheduled, you must contact your instructor in writing (by email) **at least** *two weeks* in advance to make alternative arrangements for taking the test. If you miss a test with no advance notice for a valid reason (e.g. illness), you must contact your instructor within twenty-four (24) hours of the test. At the instructor's discretion, a make-up test may be offered.

Grade Scale. The following tables breakdown the value of each assignment.

Category	Percentage
Homework	45
Participation	15
Exams	20
Final	20
Total	100

Percentage	Grade
> 90	A
80-89	B
70-79	C
60-69	D
< 60	F

Plus/ minus marks will be added to the grades at the end of the semester using 3% margins.

Resources

Campus Services.
Accessibility:
https://accessibility.iu.edu/ada/accommodations/in-class/syllabus-statement/index.html
Sexual Misconduct:
https://kokomo.iu.edu/academic-affairs/academic-resources/sexual-misconduct-statement.html
Student Handbook: https://kokomo.iu.edu/advising/handbook/
Civility: https://kokomo.iu.edu/academic-affairs/academic-resources/civility-statement.html
Student Code: https://studentcode.iu.edu/
Student in Crisis:
https://kokomo.iu.edu/student-life/advocacy-and-resources/resource-navigator.html

Getting Help. It is extremely important to keep up to date with the work in this course, and if you are having difficulty, to get help immediately. This course is not supported by the Math Commons so I highly recommend office hours (in person or virtual, if necessary). Additionally a study group or two can be extremely beneficial for this type of course.

Email. I will answer your emails as quickly as I can, but please be patient with this. Any email sent after 7p might not be seen until the following day. Please put an appropriate subject line in your message (for homework, use "M215 Sec 2.3 & 2.4" NOT "today's homework"). Also, I prefer to discuss math topics and problems in person. Please try to ask math questions in class or during office hours. However, if you do ask me a question in an email about a particular problem you are having trouble with, please include a brief explanation about your confusion and a photo of your work for me to see.

Other Information

Withdrawal Date. If it becomes necessary to withdraw from M415, it is your responsibility to complete the necessary transaction by the official deadline. Students can complete the withdrawal electronically through the Student Center. No Schedule Adjustment forms will be signed/e-approved after 4/26/2024.

Student Conduct. Students are expected to adhere to the Student Code: https://studentcode.iu.edu/ regarding classroom conduct. Any inappropriate behavior, disorderly conduct, or non-compliance with faculty directions can result in a charge of Academic and/or Personal Misconduct, which may result in the lowering of a course grade, course failure, or requirement to withdraw.

Please **turn ALL electronic communication devices to silent** before the start of class (cell phones, mp3's, laptop computers, tablets, etc.). Receiving or sending messages (voice or text) on these devices is considered disruptive behavior and can also lead to a charge of academic dishonesty. Do not text during class! Put your cell phones away, on vibrate or silent!

Quality. Your work must be legible in order to receive credit on any assignment. If I cannot read your writing, it will be considered incorrect and no partial credit will be given. You are allowed to type your assignments (I suggest using Microsoft Word, though LaTeX is in general a better program). If you have bad handwriting, you will be *required* to type your homework assignments.

Academic Integrity. Please be respectful of both myself and your fellow classmates. Do not use communication devices or CAS systems; violations will lead to charges of misconduct, lower grades, course failure, or forced withdrawal. For more details, see the Academic Integrity handout on Canvas.

This syllabus and the course schedule are subject to change at the instructor's discretion. Any such changes will be discussed in class and revisions posted promptly.

Proposed Course Schedule

Domains
Calculus in the Plane Harmonic Functions
Mean-Value Properties
Harnack's Inequality
Differentiation under Integrals
Exam 1
Complex Numbers and Complex Functions
Cauchy-Riemann Equations
Transcendental Functions and Harmonic Conjugates
Riemann Surfaces (optional)
Complex Line Integration
Cauchy Integral Theorem and Formula
Higher Derivatives of Analytic Functions
Circumferential and Solid Means
Maximum Modulus Principle
Fundamental Theorem of Algebra and Liouville's Theorem
Cauchy Inequalities for Derivatives
Exam 2
Analytic Functions and Power Series
Analytic Functions and Laurent Series
Residue Theory and The Argument Principle
Evaluation of Real Integrals by Residues
Final Exam due by 5:00 pm on 5/4/2025

INDIANA UNIVERSITY KOKOMO
MATH-M415
ELEMENTARY COMPLEX VARIABLES
COURSE LEARNING OUTCOMES

This course contributes to the fulfillment of the following goals for a degree in mathematics:

- Understand the nature of truth and the concept of proof in the discipline of mathematics
- Formulate and solve problems mathematically
- Communicate mathematical ideas clearly and effectively
- Independently comprehend mathematical material appropriate for undergraduates

Upon successful completion of MATH-M415 students will be able to:

(1) Multi-Variable Calculus
- Write a parametrization of a plane curve
- Identify a Jordan curve
- Compute normal derivatives to a function on the boundary of a domain
- Identify a harmonic function
- Compute a line integral of a differential over a Jordan curve
- Identify a differential as exact
- Find the line integral of an exact differential
- Apply Green's theorem to compute an integral
- Verify Green's identities
- Prove results about harmonic functions
- Use the mean value properties for harmonic functions to evaluate integrals
- Use Liousville's theorem to identify functions which are not harmonic

(2) Complex Numbers
- Perform arithmetic operations on complex numbers
- Plot complex numbers on the complex plane
- Identify the real and imaginary parts of a complex function
- Find the complex derivative of a function
- Use the Cauchy-Riemann equations to identify analytic functions
- Prove results about the complex exponential function
- Identify branches of the complex logarithm

(3) Complex Integration
- Compute line integrals of complex functions using parameterizations
- Use the Cauchy Integral theorem to identify an integral as zero
- Use the Cauchy Integral formula to compute integrals
- Use higher-derivative form of the Cauchy Integral formula to compute integrals
- Identify harmonic functions as the real and imaginary parts of an analytic function
- Use the Mean Value theorem to compute integrals
- Prove the Fundamental Theorem of Algebra

(4) Analytic Functions, Power Series, and Laurent Series
- Classify a complex series as convergent or divergent
- Compute the disc of convergence for a complex power series
- Find the coefficients of the power series representing an analytic function with arbitrary center
- Identify the types of isolated singularities of a complex function
- Remove a removable singularity
- Expand a function as a Laurent series about a singularity

(5) Residues
- Compute the residue of a complex function at a point

- Use the Residue theorem to compute integrals
- Compute real integrals using residues

Current textbook: *Complex Variables, Harmonic and Analytic Functions*, 1st ed. by Francis J. Flanigan