Math 321 Syllabus
Applied Mathematical Analysis I

COURSE INFORMATION

Applied Mathematical Analysis I (Vector and Complex Calculus for the Physical Sciences)
MATH 321 001 (3 Credits)
Fall 2019–2020 [1202]
Accelerated honors https://honors.ls.wisc.edu/accelerated-honors-courses/

Description
Vector analysis: algebra and geometry of vectors, vector differential and integral calculus, theorems of Green, Gauss, and Stokes; complex analysis: analytic functions, complex integrals and residues, Taylor and Laurent series.

Prerequisite(s): MATH 376, (MATH 234 and 319), (MATH 234 and 320), (MATH 234 and 340), (MATH 234 and 341), (MATH 234 and 375).

Breadths: N - Natural Science

Instruction Mode: Classroom Instruction

Department: MATHEMATICS

College: Letters and Science

Canvas URL: https://canvas.wisc.edu/courses/161777 (Main course site for Fall 2019)

Location and Schedule: Van Vleck B239 TR 9:30–10:45am

CRN: 600011647

How the Credit Hours are Met
[Traditional Carnegie Definition] This class meets for two 75-minute class periods each week over the semester and carries the expectation that students will work on course learning activities (reading, writing, problem sets, studying, etc) for *about 2 hours out of classroom for every class period.* The syllabus includes additional information about meeting times and expectations for student work.

Instructor:	Prof. Jean-Luc Thiffeault	`thiffeault@wisc.edu`, 503 Van Vleck
	Office hours	503 Van Vleck T 10:45–11:45am, R 8:30–9:20am
Teaching Assistant:	Enkhzaya (Eza) Enkhtaivan	`enkhtaivan@wisc.edu`, 716 Van Vleck
	Office hours	716 Van Vleck, R 1:00–3:00pm

GRADING AND COURSE MATERIALS

Grading
Homework (20%), two midterms (25% each), one final (30%)

The grading is 'curved' in the sense that average is about a BC if the grade distribution is sufficiently broad (or 'normal') and the average is not too high or too low. There is no set % of A's, B's, ... This 'curving' adapts to the actual cumulative scores to correct for natural variations, in exam difficulty and grading for example, since we want you to 'show your work' and we award 'partial credit'. We use the full grading scale from 0 to 100% with the guideline

$$F < 20 \lesssim D < 40 \lesssim C < 60 < B < 80 < A$$

assuming the class average is about 60%.

Course Learning Outcomes

Students will be able to

- explain the cartesian, cylindrical and spherical representations of vectors in 3D space and transform from one representation to another
- explain and use the concepts of linear independence and basis for a vector space
- state and use the geometric and algebraic properties of dot, cross, double cross and mixed products
- define and use the Kronecker and Levi-Civita symbols and the summation convention
- explain and use the geometric and algebraic properties of determinants
- state and solve problems using vector, index and matrix notations
- transform between distinct cartesian bases in 3D and define and use Euler angles to decompose orthogonal matrices
- state and use differentiation rules for vector functions
- use vector calculus techniques to solve fundamental problems in Newtonian mechanics such as rotation about an arbitrary axis and planetary motion
- write down and use vector equations for classic curves such as lines, parabolas, circles, ellipses, hyperbolas, and Bézier curves
- define and calculate arclength, curvature and torsion and the Frenet frame for curves
- formulate and use parameterizations for elementary surfaces and volumes such as planes, spheres, ellipsoids and tori.
- formulate surface and volume integrals for arbitrary parameterizations
- change variables and limits of integrations in multidimensional integrals
- explain and use the geometric and algebraic properties of gradients of scalar functions
- state and prove fundamental vector identities for grad, div and curl
- calculate divergence and curl of vector functions using a variety of approaches beyond cartesian
- express grad, div and curl in cartesian, cylindrical and spherical coordinates
- state and use the fundamental theorems of vector calculus (Green, Stokes, Gauss) in various forms
- explain and use algebra and geometry of complex numbers and variables
- define and manipulate elementary transcendental functions of a complex variable
- state and use fundamental results and theorems of complex differentiation
- state and use fundamental results and theorems of complex integration

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Discussions are 'optional' for historical administrative reasons and student flexibility. They may include quizzes and other active learning activities but these will not directly affect the grade.

Class	Section	Days & Times	Room
40983	301-DIS	W 11:00–11:50am	Van Vleck B317
40984	302-DIS	F 11:00–11:50am	Van Vleck B333

Labs: none

Textbook:

- *Precalculus Mathematics in a Nutshell* by George Simmons is a great summary of the precalculus that is essential to success in Math 321.
- Free draft Math 321 textbook posted on the *Canvas* site for this class:
  https://canvas.wisc.edu/courses/161777/files

Homework: Assigned weekly, posted at https://canvas.wisc.edu/courses/161777, due *Tuesdays beginning of lecture*. Graded for completion and one or two problems graded for accuracy. Homework is meant to be challenging and to push you to learn the material in depth. Do not expect to know what to do immediately. Try hard enough to solve the problems on your own using only the course notes and your own lecture notes. You can discuss the material with others and consult other sources but *you must specify your collaborators and sources on each homework*. Every student must submit their own written version of the homework solutions. *No email submissions. No late submissions.*

Exams: NO books, notes, calculators, phones, . . . , allowed during exams.

Exam 1	Thursday Oct 24	9:30–10:45am	in class
Exam 2	Thursday Nov 21	9:30–10:45am	in class
Final	Tuesday Dec 17	2:45–4:45pm	in TBA

Tentative schedule:

Lecture	*Material*	*Textbook Pages*
Week 1	Vector geometry and algebra; Vector Spaces, bases	9–25
Week 2	Dot & Cross products; Index notation	26–47
Week 3	Determinants; Applications of vectors	48–55
Week 4	Orthogonal Transformations, Matrices & Euler angles	56–69
Week 5	Vector functions, Newtonian Mechanics	73–83
Week 6	Curves and line integrals	88–97
Week 7	Surface, Volumes, Jacobians	98–116
Week 8	Grad, Div, Curl. Vector identities	117–124
Week 9	Grad, Div, Curl in cylindrical and spherical	125–129
Week 10	Green, Stokes & Gauss Theorems	130–142
Week 11	Complex variables and functions	143–169
Week 12	Cauchy-Riemann, Conformal mapping	170–179
Week 13	Complex integration, Cauchy's theorem, residues	179–189
Week 14	Contour integration examples	190–198

ACADEMIC POLICIES

ACADEMIC INTEGRITY

By enrolling in this course, each student assumes the responsibilities of an active participant in UW-Madison's community of scholars in which everyone's academic work and behavior are held to the highest academic integrity standards. Academic misconduct compromises the integrity of the university. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these acts are examples of academic misconduct, which can result in disciplinary action. This includes but is not limited to failure on the assignment/course, disciplinary probation, or suspension. Substantial or repeated cases of misconduct will be forwarded to the Office of Student Conduct & Community Standards for additional review. For more information, refer to https://conduct.students.wisc.edu/academic-integrity/

ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES

McBurney Disability Resource Center syllabus statement: "The University of Wisconsin-Madison supports the right of all enrolled students to a full and equal educational opportunity. The Americans with Disabilities Act (ADA), Wisconsin State Statute (36.12), and UW-Madison policy (Faculty Document 1071) require that students with disabilities be reasonably accommodated in instruction and campus life. Reasonable accommodations for students with disabilities is a shared faculty and student responsibility. Students are expected to inform faculty [me] of their need for instructional accommodations by the end of the third week of the semester, or as soon as possible after a disability has been incurred or recognized. Faculty [I], will work either directly with the student [you] or in coordination with the McBurney Center to identify and provide reasonable instructional accommodations. Disability information, including instructional accommodations as part of a student's educational record, is confidential and protected under FERPA." http://mcburney.wisc.edu/facstaffother/faculty/syllabus.php

DIVERSITY & INCLUSION

Institutional statement on diversity: "Diversity is a source of strength, creativity, and innovation for UW-Madison. We value the contributions of each person and respect the profound ways their identity, culture, background, experience, status, abilities, and opinion enrich the university community. We commit ourselves to the pursuit of excellence in teaching, research, outreach, and diversity as inextricably linked goals.

The University of Wisconsin-Madison fulfills its public mission by creating a welcoming and inclusive community for people from every background – people who as students, faculty, and staff serve Wisconsin and the world." https://diversity.wisc.edu/