

TEACHING PORTFOLIO

CHIRANTHA PIYAMAL THARUSHA BANDARA

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1. Teaching Awards

- UF Mathematics Graduate Student Teaching Award. 2022
Department of Mathematics, University of Florida.
- Certificate of Excellence in Teaching. 2021
Department of Mathematics, University of Florida.

2. Teaching Experience

Instructor.

- MAC 2311 - Calculus I University of Florida
- MAC 2311 - Calculus I (Online) University of Florida
- MAC 2233 - Survey of Calculus I University of Florida
- MAC 2312 - Calculus II University of Florida
- MAP 2302 - Elementary Differential Equations University of Florida.
- Mathematical Methods for Finance (Level I) University of Colombo
- Mathematical Modelling in Economics (Level III) University of Colombo
- Essential Mathematics for Statistics (Level III) University of Colombo
- Intermediate Mathematics University of Colombo
- Calculus for Biology and Medicine China Lanka Education Institute

Teaching Assistant.

- MAC 1140 - Precalculus Algebra University of Florida
- MAC 2311 - Calculus I University of Florida
- MAC 2313 - Calculus III University of Florida
- MAP 2302 - Elementary Differential Equations University of Florida
- MAS 3114 - Computational Linear Algebra University of Florida
- Matrices (Level I) University of Colombo
- Differential Equations I (Level I) University of Colombo
- Vectors (Level I) University of Colombo
- Algebra (Level II) University of Colombo
- Calculus II (Level II) University of Colombo

3. Teaching Statement

Delving into the realm of teaching mathematics unveils a challenge arguably more formidable than mastering the subject itself. Reflecting on our own journeys, we all encountered that singular professor who ignited an unequivocal passion for math within us. What sets them apart from their peers? What renders them more impactful and effective in their pedagogical pursuits? In alignment with this sentiment, I always strive to be that one teacher who makes a difference and ignites a similar passion for mathematics in my students.

A Decade in Education: A Chronicle of My Teaching Experience

Throughout graduate school, I assumed dual roles as an instructor and teaching assistant for an array of courses encompassing linear algebra, single and multi-variable calculus, and differential equations. In recognition of my dedication and enthusiasm for teaching, I was awarded the Certificate of Excellence in Teaching by the Department of Mathematics at the University of Florida in 2021. In the subsequent year, 2022, I was humbled to receive the Graduate Student Teaching Award, a testament to my unyielding commitment to the artistry of education.

My journey as an educator predates my time in graduate school. Having concluded my undergraduate studies in mathematics in Sri Lanka in 2017, I was soon recruited as an instructor in the Department of Mathematics at the University of Colombo on a merit basis. During my tenure, I was assigned to teach two junior-level undergraduate courses, namely, Mathematical Modeling in Economics (which consisted of 120+ students) and Essential Mathematics for Statistics. In addition to these lectures, I have conducted many tutorial classes in both pure and applied mathematics. In the meantime, I had the opportunity to work as a visiting lecturer in the Faculty of Arts at the University of Colombo. My unflinching passion for solving complicated mathematical riddles urged me to embrace a huge responsibility in the Sri Lanka Olympiad Mathematics Foundation as a trainer and resource person. There, I conducted several national-level workshops for K-12 teachers and students on Olympiad mathematics problems, and I am glad that in this venture, I was fortunate enough to successfully spread the message of the immense importance of rigorous mathematical practice throughout the island. During this period, I also delivered lectures at a private institute on mathematics tailored for students aspiring to pursue medical studies at Tianjin Medical University, China. This experience further enhanced my proficiency in adapting teaching methods to accommodate diverse learning goals and objectives within a classroom setting. Prior to such formal experience as a teacher and trainer, I spent countless hours as an undergraduate informally teaching my colleagues in the university. All these experiences enabled me to become flexible in my teaching approaches and effectively cater to the diverse needs of students who are at different ages and cognitive levels.

Guiding Minds: A Choreography of Classroom Pedagogy

My teaching philosophy revolves around creating an inclusive and engaging learning environment that embraces diversity and encourages active participation. I aspire to enhance the critical thinking and logical reasoning skills of my students, simultaneously fostering the development of their problem-solving abilities. These skills are paramount for success in mathematics and play a crucial role in preparing them to attain their educational and career objectives.

At the outset of each class, I allocate 5-10 minutes to address queries and provide a succinct overview of the previous material. This practice is pivotal, as it establishes a shared understanding and prevents the class from faltering, particularly when a segment of the students might otherwise feel disoriented. I frequently engage students in the classroom by presenting material as problems during class. For instance, when teaching optimization in Calculus, I pose the challenge of designing a cylindrical can with a fixed volume (V) to minimize material costs. This problem encourages critical thinking, as it requires them to reason methods to minimize the cost, and it also demands a blend of mathematical skills, logical reasoning, and creative problem-solving.

Mathematics inherently possesses an abstract nature, due to its conceptual intricacies, rigid structures, and logical elegance. As a teacher, however, I try to bridge the gap between theoretical abstraction and practical application, thus establishing a clear connection with the real world. The incorporation of real-world examples is considered a robust pedagogical approach, which helps reinforce the comprehension of the underlying concepts. With almost a decade of experience as a mathematics educator and a background working with a diverse student body, I have noted a pronounced enthusiasm and motivation among students when mathematical concepts are contextualized through relatable applications. During my tenure as a visiting lecturer in the Faculty of Arts at the University of Colombo, where students were Humanities majors, I encouraged them to fuse their artistic knowledge into their final projects. Amongst many, I was amazed to see that one of my students created an art comprising of a repetition which can be attributed to the mathematical principle of tessellation, and another student created a floral-inspired artistic representation, mathematically shaped by the polar equation $r = b \sin(4\theta)$.

Moreover, a pivotal component of effective teaching is the assessment of student competency. I strongly believe in the idea that ‘the only way to learn mathematics is to do mathematics.’ As such, I assign weekly homework problems to my students and provide them with detailed feedback on their work to facilitate their understanding. In larger classes, I ensure, at the very least, the availability of homework solutions, encouraging students to discuss them further during office hours. To sustain student engagement, I opt for multiple exams throughout the semester. This approach not only gauges their comprehension but also serves to keep them actively involved in the learning process. I consistently create concise, focused short notes (apart from the more complete lecture notes that cover every aspect of the material being taught) that highlight crucial concepts and problem-solving techniques. These sets of short notes have become the cornerstone of extra review sessions that I conduct before each exam. This practice has garnered admiration from my students over the years. Whenever possible, I include a final project as one of the major items of the assessment process in my syllabus. This aligns with my belief in student-oriented teaching, providing students with the opportunity to apply the freshly-acquired mathematical concepts acquired during the semester to real-world examples that resonate with them personally. Kindly click on the following [LINK](#) to access my Teaching Portfolio, where you will find a sample syllabus, lecture notes, instructor evaluations, and more.

The diversity among students in a classroom unveils a nuanced duality. On one front, there’s the rich tapestry of varied cultural and educational backgrounds. As their instructor, it is my responsibility to establish a secure space within the classroom, fostering an environment where students can freely express themselves. Hailing from a small island in the Indian Ocean, I intimately understand and can relate to the unique challenges, faced by students from underrepresented communities.

On the other hand, students exhibit diverse learning styles, each absorbing material through distinct methods. Echoing the wisdom of my mother, a language teacher, who often said, “Some see with eyes and some see with ears”, I consciously craft material that bridges conceptual ideas with real-world examples. When in front of the class, I aim to articulate these connections at a pace that accommodates everyone comfortably. It typically takes a few weeks to discern the ‘pace’ of a class, necessitating effective and honest communication with the students. I make a deliberate effort to learn every student’s name, even in larger classes. This simple act makes the students feel valued and respected and promotes effective conversations. Infusing a drop of kindness into this multifaceted approach results in a classroom environment where everyone feels at ease and enthusiastically focused on the learning journey. I believe that all scholars ought to give significant attention to the practice of teaching as it is how we ensure that knowledge is continually enriched and passed through the generations. I intend to do the same and wish to express here my earnest willingness to serve as a postdoctoral fellow in mathematical biology if considered.

4. Student Evaluations of Teaching

The student evaluations below were gathered from GatorEvals, the University of Florida's comprehensive course and instructor evaluation system. For additional student feedback and course evaluations, please refer to this [LINK](#).

Spring 2021 Individual Instructor Aggregated Report for MAC2311: Calculus I

Question	Mean
The instructor was enthusiastic about the course.	4.90
Explained the material clearly and in a way that enhanced my understanding.	5.00
The instructor maintained clear standards for response and availability	4.95
The instructor fostered a positive learning environment that engaged students.	4.98
Provided prompt and meaningful feedback on my work and performance in the course.	4.90
The instructor was instrumental to my learning in the course.	4.93

TABLE 1. Spring 2021

Summer 2021 Individual Instructor Aggregated Report for MAC2233: Survey of Calculus I

Question	Mean
The instructor was enthusiastic about the course.	4.92
Explained the material clearly and in a way that enhanced my understanding.	5.00
The instructor maintained clear standards for response and availability	4.85
The instructor fostered a positive learning environment that engaged students.	5.00
Provided prompt and meaningful feedback on my work and performance in the course.	4.92
The instructor was instrumental to my learning in the course.	4.92

TABLE 2. Summer 2021

Fall 2021 Individual Instructor Aggregated Report for MAC2313: Calculus III

Question	Mean
The instructor was enthusiastic about the course.	5.00
Explained the material clearly and in a way that enhanced my understanding.	5.00
The instructor maintained clear standards for response and availability	5.00
The instructor fostered a positive learning environment that engaged students.	5.00
Provided prompt and meaningful feedback on my work and performance in the course.	5.00
The instructor was instrumental to my learning in the course.	5.00

TABLE 3. Fall 2021

Spring 2022 Individual Instructor Aggregated Report for MAC2313: Calculus III

Question	Mean
The instructor was enthusiastic about the course.	4.94
Explained the material clearly and in a way that enhanced my understanding.	4.88
The instructor maintained clear standards for response and availability	4.50
The instructor fostered a positive learning environment that engaged students.	4.91
Provided prompt and meaningful feedback on my work and performance in the course.	4.59
The instructor was instrumental to my learning in the course.	4.84

TABLE 4. Spring 2022

Summer 2022 Individual Instructor Aggregated Report for MAC2312: Calculus II

Question	Mean
The instructor was enthusiastic about the course.	5.00
Explained the material clearly and in a way that enhanced my understanding.	4.86
The instructor maintained clear standards for response and availability	5.00
The instructor fostered a positive learning environment that engaged students.	5.00
Provided prompt and meaningful feedback on my work and performance in the course.	4.71
The instructor was instrumental to my learning in the course.	4.86

TABLE 5. Summer 2022

Fall 2022 Individual Instructor Aggregated Report for MAC2311: Calculus I

Question	Mean
The instructor was enthusiastic about the course.	4.66
Explained the material clearly and in a way that enhanced my understanding.	4.31
The instructor maintained clear standards for response and availability	4.26
The instructor fostered a positive learning environment that engaged students.	4.63
Provided prompt and meaningful feedback on my work and performance in the course.	4.23
The instructor was instrumental to my learning in the course.	4.37

TABLE 6. Fall 2022

5. Quoted Student Comments

The comments below were gathered from GatorEvals, the University of Florida's comprehensive course and instructor evaluation system. For additional student feedback and course evaluations, please refer to this [LINK](#).

- The instructor provided us with a lot of questions that greatly helped us during exam times. He clearly explains all the theorems and topics and ensures that all students understand the concept. He always makes sure to answer the doubts of all the students and helped us with particularly hard topics. He also makes sure to keep the students interested in class and constantly encouraged us to do better. **(Fall 2022)**
- The instructor provided us with a lot of questions that greatly helped us during exam times. He clearly explains all the theorems and topics and ensures that all students understand the concept. He always makes sure to answer the doubts of all the students and helped us with particularly hard topics. He also makes sure to keep the students interested in class and constantly encouraged us to do better. **(Fall 2022)**
- Best TA I've ever had. So kind, understanding, and passionate about the subject. **(Spring 2021)**
- This man was the absolute greatest TA that I have ever had. He always explained everything in a lot of detail, and he never rushed through anything. He also always answered questions and made sure we all understood before he moved on. Also, he literally held 2–3 hour review sessions on his own time for every exam. I wish I could have him as my TA forever. **(Spring 2021)**
- Extremely helpful and willing to even help after discussion period was over. Kind and accommodating. Communicated well and designed meaningful discussion coursework. **(Fall 2021)**
- Mr. Bandara's commitment to his students was beyond my expectations. Over the semester he dedicated countless hours out of his week to spend 4–5 hours at review sessions with us in preparation for an exam. Whenever I had a question I was easily able to send an email and he would be back quickly with a response. Mr. Bandara truly has an extreme dedication to the preparation of his students and their individual success. **(Fall 2020)**
- This man showed a lot of dedication to the course. He was willing to answer questions and assist students any time of day. He even held extra study sessions before exams. A great teacher and person all around! **(Fall 2019)**
- Mr. Bandara was the most phenomenal T.A I have had. He is extremely knowledgeable and is more than willing to help his students in any way possible. He went above and beyond for us. He is able to explain things in many ways so each student understands and was always encouraging throughout our learning experience. **(Fall 2019)**
- Without Mr. Bandara I would not have passed this class or learned any mathematical concepts from it at all. He was amazing at explaining things that were actually relevant to this class clearly and in a timely manner. He was always prepared for every class and smart enough to answer any question a student came up with. Also if a question was presented he would be able to demonstrate it using examples to further my knowledge about the topic. He made time for his students and was always willing to help no matter when. Honestly, he needs a raise because I know every other student who had him agrees with me. **(Fall 2019)**

6. Representative Course Syllabi, Lecture Notes, and Homework

Designing courses in a comprehensive and methodical way is vital to the teaching process. I always provide comprehensive, well-written lecture notes to all my classes. I also create concise, focused short notes that highlight crucial concepts and problem-solving techniques. These sets of short notes have become the cornerstone of extra review sessions that I conduct before each exam.

Here, I have included representative samples of the teaching materials I have developed over the last several years. More precisely, I have included the following in the appendices:

- (1) **Appendix A:** Syllabus for the Differential Equations (Fall 2023) class I teach at the University of Florida.
- (2) **Appendix B:** A lecture from my Calculus II class at the University of Florida, where I introduced the concept of an infinite sequence.
- (3) **Appendix C:** Homework assignment for the aforementioned lecture on infinite sequences.
- (4) **Appendix D:** A set of short notes from my role as a TA for Calculus III.

Appendix A: Sample Syllabus

MAP2302 Elementary Differential Equations Online: Fall 2023

Instructor	Chirantha Tharusha Bandara
Office	LIT405
Office hours	M, W, F - 3:00:3:50PM (Zoom)
Email	bandarac@ufl.edu

Canvas Messages: Check your messages **daily** so that you do not miss any important announcements.

Text: Fundamentals of Differential Equations and Boundary Value Problems by R. Kent Nagle, Edward B. Saff and Arthur David Snider, ISBN-13: 978-0321977106, ISBN-10: 9780321977106. You may use the previous edition and/or the version without boundary value problems if you prefer.

Requirements: A hardwired connection (not wireless) is strongly recommended when working and submitting assignments. It is the student's responsibility to have a reliable internet connection, adequate internet speed and cleared cache and cookies before starting each assignment .

Time commitment: University students are expected to spend at least 3 hours for each hour watching lecture videos in order to keep up with the course material.

Content: We will cover Chapters 1(Introduction), 2(First Order ODEs), 4(Second Order ODEs), 7(Laplace Transforms), and some of 8(Series Solutions). Chapter 6 (Theory of Higher Order Differential Equations) is optional.

Homework: Doing homework is essential to success in this course and is one of the best ways to prepare for quizzes and tests. Online homework is completed in Canvas. Homework is worth 7% of the grade. The lowest two scores are dropped. Each homework has **unlimited attempts**. Students who miss parts of a multiple-part question should feel free to ask about which parts were missed.

Lecture Quizzes: There is a lecture quiz for each lecture with 2-4 pooled questions with **two attempts** each. The lowest two scores are dropped. Lecture Quizzes are worth 10% of the course grade.

Quizzes: There will be ten online quizzes covering 2-4 lectures with **one attempt** each. The lowest two scores are dropped. Quizzes are worth 13% of the course grade. Online quizzes are 30-50 minutes long.

Discussion board: There is one discussion board for each exam period. If you have a question, please show your work and state the assignment from which the problem comes. The question must not have already been asked so read the boards daily. If you ask a question that has been answered in an online conference, you will be directed to watch the video of that conference unless you require specific clarification. Discussion boards are locked at 10 PM the night before each exam.

Practice Exams: Four online practice exams are available in quiz format Canvas. They are not for credit.

Exams: Four online exams will be given from 7PM-9PM on the dates shown in the calendar. The exams will be administered via Honorlock. The fourth (final) exam is comprehensive. Each is worth 17.5% of your grade. No external aids or devices such as calculators or cell phones are permitted, nor is use of other websites, discord servers, Group Me, and the like.

Precalculus Quiz: This quiz is designed for students to determine if their precalculus skills are adequate for success in this course. Students should take the quiz without aids before the end of the drop/add period. A complete set of precalculus notes is available in Canvas for review.

Grades: The letter grade will be awarded with Canvas rounding up the display grade (i.e. 89.5 counts as A) as follows:

A	90%-100%	C	70%-74%
A-	87%-89%	C-	67%-69%
B+	85%-86%	D+	64%-66%
B	80%-84%	D	60%-63%
B-	77%-79%	D-	57%-59%
C+	75%-76%	E	0-56%

If you have a grade dispute, please resolve it with your instructor **within a week** of the assignment deadline. Your grade is comprised of the following:

4 Exams 17.5% each
 Quizzes 13% (drop two lowest scores)
 Homework 7% (drop lowest two scores)
 Lecture Quizzes 10% (drop lowest two scores)

Total: 100%

Exam Coverage

Exam 1 covers 1.1-1.4, 2.2-2.6 and applications (L1-L10)

Exam 2 covers 4.1-4.7 (L11-L17)

Exam 3 covers 7.2-7.6, 7.8-7.9 (L18-L24)

Exam 4 is comprehensive, approximately 50% chapter 8 (L25-L28) with the remainder from chapters 1-2, 4, and 7 (L1-24).

Accommodations for students with learning disabilities: Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting disability.ufl.edu/students/get-started

Academic Honesty: The course will be conducted in accord with the University honor code and academic honesty policy which can be found at www.dso.ufl.edu/sccr/honorcodes/honorcode.php. The Mathematics Department expects you to follow the Student Honor Code. We are bound by university policy to report any instance of suspected cheating to the proper authorities.

In addition, we remind you that lectures and the lecture notes given in this class are the property of the University/faculty member and may not be taped/shared without prior permission from the lecturer and may not be used for any commercial purpose. Students found to be in violation may be subject to discipline under the Student Conduct Code.

Makeup Exams: If you miss an exam with valid documentation, you may take a makeup. If you miss without valid documentation, there will be a 20% penalty. Valid documentation includes documented illness, school-sponsored activity, death in the immediate family, court-ordered or military appointments, and religious holidays. Scheduled flights do not count as valid documentation so do not make plans for a flight which conflicts with exam dates and times. If you miss a second exam, the comprehensive fourth exam will replace it. Exam makeups are held on Tuesday, November 28.

If you have a conflict with another assembly exam in a course that has a higher course number,

please notify the coordinator within the first two weeks of the semester to qualify for a makeup.

If illness or other extenuating circumstances cause you to miss an exam, contact the course coordinator immediately (no later than 24 hours after the exam) by email. Then, as soon as possible after you return to campus, bring the appropriate documentation to the course coordinator.

To be eligible for a make-up you must have completed at least 75% of the course work that has been given so far.

Late submissions: Due date is not do date! Please do not wait begin your assignments the day that they are due. If there are any last minute difficulties with your computer or access, you will be out of luck. Homework and quizzes can be submitted late with a 25% penalty for each day beyond the due date. If documented illness or other extenuating circumstances cause you to miss a deadline for an assignment you will be granted extensions. You must contact the course coordinator for details.

False Late penalties: There is a feature in Canvas associated with late penalties such that if you have completed an assignment on time but review it at a later date, Canvas will assign a late penalty. These penalties must be removed by the coordinator by hand. To prevent such occurrences, please keep written records of all your work rather than opening past-due assignments that you have already completed.

Evaluations: Course evaluations are now at <https://gatorevals.aa.ufl.edu/>

Privacy: Our class sessions, including office hours, may be audio-visually recorded for students in the class to refer back and for enrolled students who are unable to attend live. Students who participate with their camera engaged or utilize a profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate verbally are agreeing to have their voices recorded.

If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the “chat” feature, which allows students to type questions and comments live. The chat will not be recorded or shared.

As in all courses, unauthorized recording and unauthorized sharing of recorded materials is prohibited.

Diversity: The Mathematics Department is committed to diversity and inclusion of all students. We acknowledge, respect, and value the diverse nature, background and perspective of students and believe that it furthers academic achievements. It is our intent to present materials and activities that are respectful of diversity: race, color, creed, gender, gender identity, sexual orientation, age, religious status, national origin, ethnicity, disability, socioeconomic status, and any other distinguishing qualities.

Campus Resources:

Health and Wellness U Matter, We Care: If you or someone you know is in distress, please contact umatter@ufl.edu, 352-392-1575, or visit U Matter, We Care website to refer or report a concern and a team member will reach out to the student in distress.

Counseling and Wellness Center: Visit the Counseling and Wellness Center website or call 352-392-1575 for information on crisis services as well as non-crisis services. **Student Health Care Center:** Call 352-392-1161 for 24/7 information to help you find the care you need, or visit the Student Health Care Center website.

University Police Department: Visit UF Police Department website or call 352-392-1111 (or 9-1-1 for emergencies).

UF Health Shands Emergency Room / Trauma Center: For immediate medical care call 352-733-0111 or go to the emergency room at 1515 SW Archer Road, Gainesville, FL 32608; Visit the UF Health Emergency Room and Trauma Center website.

GatorWell Health Promotion Services: For prevention services focused on optimal wellbeing, including Wellness Coaching for Academic Success, visit the GatorWell website or call 352-273-4450.

Academic Resources E-learning technical support: Contact the UF Computing Help Desk at 352-392-4357 or via e-mail at helpdesk@ufl.edu.

Career Connections Center: Reitz Union Suite 1300, 352-392-1601. Career assistance and counseling services.

Library Support: Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center: Broward Hall, 352-392-2010 or to make an appointment 352- 392-6420.

General study skills and tutoring. Writing Studio: 2215 Turlington Hall, 352-846-1138. Help brainstorming, formatting, and writing papers.

Student Complaints On-Campus: Visit the Student Honor Code and Student Conduct Code webpage for more information.

On-Line Students Complaints: View the Distance Learning Student Complaint Process.

Tentative due dates (subject to possible revision)

Mon	Tues	Wed	Thur	Fri
Aug221	22	23	24	25
				HW1/LQ1 Syllabus Quiz
28	29	30	31	Sept 1
HW2/LQ2		HW3/LQ3	Q1(L1-3)	HW4/LQ4
4	5	6	7	8
holiday		HW5/LQ5		HW6/LQ6
11	12	13	14	15
HW7/LQ7	Q2(L4-6)	HW8/LQ8		HW9/LQ9
18	19	20	21	22
Q3(L7-9), PE1	Exam1 (L1-9)			
25	26	27	28	29
HW10/LQ10		HW11/LQ11		HW12/LQ12
Oct 2	3	4	5	6
HW13/LQ13	Q4(L11-13)	HW14/LQ14		homecoming
9	10	11	12	13
HW15/LQ15	Q5(L14-15)	HW16/LQ16		
16	17	18	19	20
		HW17/LQ17	Q6(L16-17)	PE2
23	24	25	26	27
Exam 2 (L11-17)		HW18/LQ18		HW19/LQ19
30	31	Nov 1	2	3
HW20/LQ20		HW21/LQ21	Q7(L18-21)	HW22/LQ22
6	7	8	9	10
HW23/LQ23		HW24/LQ24	Q8(L22-24)	holiday
13	14	15	16	17
PE3		Exam 3 (L18-24)		
20	21	23	24	25
HW25/LQ25		holiday	holiday	holiday
27	28	29	30	Dec 1
HW26/LQ26	Q9(L25-26)	HW27/LQ27		HW28/LQ28
	Exam 1-3 makeup			
4	5	6	7	8
	Q10(L27-28)	PE4	Reading	Reading

HW: 28 homework (unlimited attempts, drop 2 lowest) due 11:59 PM

LQ: 28 lecture quizzes (2 attempts, drop 2 lowest) due 11:59 PM

Q: 10 quizzes (1 attempt, drop 2 lowest) due 11:59 PM

PE: 4 practice exams (unlimited attempts) not for credit

Final Exam date (L1-28): Monday, December 11

Tentative Lecture Schedule (subject to possible revision)

Mon	Tues	Wed	Thur	Fri
Aug21	22	23	24	25
		Intro, L1		L2
28	29	30	31	Sept 1
L3		L4		L5
4	5	6	7	8
holiday		L6		L7
11	12	13	14	15
L8		L9		Review
18	19	20	21	22
Review	Exam1 (L1-9)	L10		L11
25	26	27	28	29
L12		L13		L14
Oct 2	3	4	5	6
L14		L15		homecoming
9	10	11	12	13
L16		L16/L17		L17
16	17	18	19	20
		L18		Review
23	24	25	26	27
Review		L19		L20
Exam 2 (L11-17)				
30	31	Nov 1	2	3
L21		L22		L23
6	7	8	9	10
L24		Catch Up		holiday
13	14	15	16	17
Review	Exam 3 (L18-24)	L25		L25/L26
20	21	22	23	24
L26/L27		holiday	holiday	holiday
27	28	29	30	Dec 1
L27/L28	Exam1- 3 makeup	L28		Catch up/Review
4	5	6	7	8
Review		Review	Reading	Reading

Lecture Topics and Tentative Book HW for extra practice (not collected for grade)

Ed.		7th (mechanical clock)	6th (apple)
Lec	section	problems	problems
1	1.1 Background	1-11 odds	same
2	1.2 Solutions and IVPs	1-11 odds, 21-27 odds	same
3	1.3 Direction Fields	1-7 odds, 11-17 odds	same
4	1.4 Euler Method	1,3,5, take two steps only	same
5	2.2 Separable	1-25 odds	same
6	2.3 Linear	1-21 odds	same
7	2.4 Exact	1-25 odds	same
8	2.5 Exact w/ Integrating Factor	1-11 odds	same
9	2.6 Substitutions	1-27 odds	same
10	1st order apps	2.4 33, 3.2 23-25 3.3 1-5 odds	same
11	4.1 Mass Spring Oscillator	1-9	same
12	4.2 Linear 2nd Order	1-19 odds, 27-31 odds	same
13	4.3 Complex Roots	1-25 odds	1-17 odds, 21-25 odds
14	4.4 Undetermined Coefficients	1-25 odds, 27-31 odds	same
15	4.5 Superposition	9-35 odds	11-19 odds, 23-25 odds, 31-35 odds
16	4.6 Variation of Parameters	1-9 odds, 11	same
17	4.7 Variable Coefficients	1-13 odds, 19-20, 41-44	1-13 odds, 19-20, 37-39 odds, 45-47 odds
18	7.2 Laplace Transform	1-19 odds	same
19	7.3 Properties	1-9 odds, 13-17 odds, 25	same
20	7.4 Inverse Laplace Transform	1-25 odds	same
21	7.5 Solving IVPs	1-7 odds, 12, 15-23 odds	same
22	7.6 Discontinuous Functions	1-17 odds, 21-23 odds, no sketch	1-17 odds
23	7.8 Convolution	1-21 odds, 23, 25	7.7 1-21 odds, 23, 25
24	7.9 Dirac delta	1-17 odds, no sketch, 25, 27	7.8 1-17 odds, no sketch, 25, 27
25	8.1 Taylor Polynomial	1-5 odds, 9a	same
26	8.2 Power Series	1-5, odds, 11-13 odds, 17-27 odds, 29, 33	same
27	8.3 Power Series Solutions	1-27 odds	same
28	8.4 Analytic Coefficients	1-15 odds	same

Appendix B: Sample Notes

Sequences

The importance of sequences and series in calculus stems from the idea of representing functions as sums of infinite series. In fact, many of the functions that arise in mathematics are defined as sums of series, and therefore it is important to have a solid understanding of infinite sequences and series.

Definition

A sequence is a list of objects that have a particular order:

$$a_1, a_2, a_3, \dots, a_n, \dots$$

Similar to a set, a sequence consists of individual entities referred to as *objects* or *elements*. However, unlike a set, the significance of the order in which these elements appear is crucial in the context of sequences. In formal terms, a sequence can be defined as a function with a domain that is a countable, totally ordered set, such as the natural numbers \mathbb{N} .

Notation

The sequence $\{a_1, a_2, a_3, \dots, a_n, \dots\}$ is often denoted by $\{a_n\}$ or $\{a_n\}_{n=1}^{\infty}$.

Important Notes & Examples

- (1) A sequence can be represented by using the above notation, by using the defining formula or the general term, or by writing down the terms of the sequence.

$$\begin{array}{ccc} \left\{ \frac{(-1)^n}{n} \right\}_{n=1}^{\infty} & a_n = \frac{(-1)^n}{n} & \left\{ -1, \frac{1}{2}, \frac{-1}{3}, \dots, \frac{(-1)^n}{n}, \dots \right\} \\ \left\{ \frac{n+1}{n^2} \right\}_{n=1}^{\infty} & a_n = \frac{n+1}{n^2} & \left\{ 2, \frac{3}{4}, \frac{4}{9}, \dots, \frac{n+1}{n^2}, \dots \right\} \end{array}$$

- (2) The index, n , does not have to start at 1. Take a look at the following sequence.

$$\left\{ \frac{n}{n^2 - 7} \right\}_{n=3}^{\infty} \quad a_n = \frac{n}{n^2 - 7} \quad \left\{ \frac{3}{2}, \frac{4}{9}, \frac{5}{18}, \dots, \frac{n}{n^2 - 7}, \dots \right\}$$

- (3) Some sequences may not specify the starting index n . In that case, we assume that n starts at 1.
- (4) Some sequences do not have a general term. For example, consider the sequence $\{a_n\}_{n=1}^{\infty}$, where $a_n = n^{\text{th}}$ digit of π . This sequence does not have a general term. However, we can write the sequence precisely in the form $\{3, 1, 4, 1, 5, 9, 2, 6, \dots\}$.

Limits of Sequences

Consider the sequence

$$\{a_n\}_{n=1}^{\infty} = \left\{ \frac{1}{n} \right\}_{n=1}^{\infty} = \left\{ 1, \frac{1}{2}, \frac{1}{3}, \dots \right\}.$$

As we increase n , the terms of the sequence are getting smaller and smaller. The hundredth term of the sequence is $1/100 (= 0.01)$. The thousandth term of the sequence is $1/1000 (= 0.001)$. In fact, the terms of the sequence can be made as close to 0 as we like by taking n sufficiently large. This leads to the following intuitive definition for the limit of a sequence.

Intuitive Definition of a Limit of a Sequence

Informally speaking, a sequence $\{a_n\}$ has the limit L if we can make the terms a_n as close to L as we like by taking n sufficiently large, and we write

$$\lim_{n \rightarrow \infty} a_n = L.$$

When the above limit exists, we say that the sequence *converges*. Otherwise, we say that the sequence *diverges*.

We say the sequence a_n diverges to ∞ if $\lim_{n \rightarrow \infty} a_n = \infty$, and we say the sequence a_n diverges to $-\infty$ if $\lim_{n \rightarrow \infty} a_n = -\infty$. We shall discuss more about this later.

Precise Definition of a Limit of a Sequence

We say that a sequence $\{a_n\}$ has the limit L , if for each $\epsilon > 0$, there is an integer N such that

$$|a_n - L| < \epsilon \quad \text{whenever } n > N.$$

The use of the precise definition of the limit is beyond the scope of this class. We will instead focus on practical applications and intuitive interpretations that facilitate a comprehensive grasp of the concept.

To be continued...

Appendix C: Homework

Homework

(1) Write down the first few terms of each of the following sequences.

(a) $\left\{\frac{n}{n+1}\right\}_{n=1}^{\infty}$

(b) $\{2n^2 - n\}_{n=1}^{\infty}$

(c) $\left\{\frac{1}{n^2+1}\right\}_{n=0}^{\infty}$

(d) $\left\{\frac{(-1)^n(n+5)}{(n^2+1)^2}\right\}_{n=2}^{\infty}$

(e) $\{\sin(n\pi)\}_{n=0}^{\infty}$

(2) Find the general term a_n of the following sequences.

(a) $\{1, \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \frac{1}{5}, \dots\}$.

(b) $\{1, -2, 3, -4, 5, \dots\}$.

(c) $\{-1, \frac{1}{2}, -\frac{1}{4}, \frac{1}{8}, -\frac{1}{16}, \dots\}$.

(d) The Fibonacci Sequence: $\{1, 1, 2, 3, 5, 8, 13, 21, \dots\}$.

(e) $\{a_n\}$, where $a_n = n^{\text{th}}$ digit of e .

(3) What does it mean to say that

$$\lim_{n \rightarrow \infty} a_n = 4.$$

(4) Suppose $a_n = \frac{1}{n}$. How close is a_5 to the limit of the sequence? Find the n so that a_n is no more than 10^{-2} away from $\lim_{n \rightarrow \infty} a_n$.

(5) Determine whether the sequence converges or diverges. If it converges, find the limit.

(a) $\{n\}$

(b) $\{(-1)^n\}$

(c) $\left\{\frac{(-1)^n}{n}\right\}$

(d) $\{\cos(2n\pi)\}$

(e) $\left\{\frac{(n-1)!}{(n+1)!}\right\}$

Appendix D: Short Notes (for Exam Preparation)

Lecture 8

Arc Length

Consider a curve $\vec{r}(t) = \langle f(t), g(t), h(t) \rangle$, $a \leq t \leq b$, where f' , g' and h' are continuous. If the curve is traversed exactly once as t increases from a to b , then its length is

$$L = \int_a^b \sqrt{[f'(t)]^2 + [g'(t)]^2 + [h'(t)]^2} dt = \int_a^b |\vec{r}'(t)|$$

Arc Length Function

Suppose C is a piecewise smooth curve given by a vector-valued function $\vec{r}(t) = \langle f(t), g(t), h(t) \rangle$, $a \leq t \leq b$. The arc length function is defined by

$$s(t) = \int_a^t |\vec{r}'(u)| du.$$

The fundamental theorem of calculus tells us that s is a differentiable function of t and

$$\frac{ds}{dt} = |\vec{r}'(t)|.$$

Curvature

The curvature of a curve is defined by

$$\kappa = \left| \frac{d\hat{T}}{ds} \right|.$$

We use the following two formulas to calculate the curvature.

$$\begin{aligned} \kappa(t) &= \frac{|\hat{T}'(t)|}{|\vec{r}'(t)|} \\ \kappa(t) &= \frac{|\vec{r}'(t) \times \vec{r}''(t)|}{|\vec{r}'(t)|^3} \end{aligned}$$

Special case: if we have a plane curve given by a function $f(x)$, then the curvature is:

$$\kappa(x) = \frac{|f''(x)|}{(1 + [f'(x)]^2)^{3/2}}$$

Lecture 9

Normal Vectors

The principal unit normal vector is given by

$$\hat{N}(t) = \frac{\hat{T}'(t)}{|\hat{T}'(t)|}.$$

It points in the direction that the curve is turning.

There is also a third direction, called the unit binormal vector, and it is given by

$$\hat{B}(t) = T\hat{T}(t) \times N\hat{N}(t).$$

Movement in Space

Suppose you are a point, moving along the curve $\vec{r}(t) = \langle x(t), y(t), z(t) \rangle$. Then

$$\text{velocity} = \vec{v}(t) = \vec{r}'(t) = \langle x'(t), y'(t), z'(t) \rangle$$

$$\text{speed} = |v(t)| = \sqrt{x'(t)^2 + y'(t)^2 + z'(t)^2}$$

$$\text{acceleration} = v''(t) = \langle x''(t), y''(t), z''(t) \rangle$$

The acceleration can actually be written as a linear combination of \hat{T} , \hat{N} as

$$\vec{a}(t) = a_T(t)\hat{T}(t) + a_N(t)\hat{N}(t),$$

where

$$a_T(t) = \frac{\vec{v}(t) \cdot \vec{a}(t)}{|\vec{v}(t)|}$$

$$a_N(t) = \frac{|\vec{v}(t) \times \vec{a}(t)|}{|\vec{v}(t)|}$$

Problems

- (1) Find the length of the curve $r(t) = \langle 2t, t^2, \frac{1}{3}t^2 \rangle$, $0 \leq t \leq 1$.
- (2) Find the vectors \hat{T} , \hat{N} and \hat{B} to the curve $\vec{r}(t) = \langle 4 \ln \cos(t), 5 \cos(t), 5 \sin(t) \rangle$ at the point $(0, 5, 0)$.
- (3) Find the tangential component a_T and normal component a_N of acceleration for the space curve $\vec{r}(t) = \langle \cos(3t), \sin(3t), 1 \rangle$ at the time $t = \pi/4$.
- (4) Find the curvature of the parabola $y = x^2$. What happens to the curvature as $x \rightarrow \infty$?