Math 401 [M]: Introduction to Analysis I

Credits	3
Section	02 (Pullman), 01 (Vancouver)
Time	Tue+Thu 1:30–2:45 PM
Location	SPRK 233 (P), VECS 125 (V), Zoom (ID: 995 1412 6736, Pwd: 3853)
Instructor	Bala Krishnamoorthy
Instructor location	VLIB 210P (Vancouver), Zoom (ID: 360 546 9167, Pwd: Bala)
Check-in Hours	Wed, Thu 10:30–11:30 AM
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Course web page	http://bala-krishnamoorthy.github.io/Math401.html
Text	Tom L. Lindstrøm Spaces An introduction to Real Analysis AMS. ISBN: 9781470440626

Description of the Course

This course offers an introduction to real analysis at the senior undergraduate level. Real analysis is a continuation of calculus, and many of the concepts we introduce in this class should be familiar from calculus, e.g., functions, continuity, convergence, etc. But we will introduce these concepts in new, more abstract, contexts. The biggest change from calculus to real analysis is a shift in emphasis from calculations to formal arguments or proofs.

We will cover Chapters 1–4 from the book (Lindstrøm: Spaces An Introduction to Real Analysis). Topics covered include preliminaries (proofs, sets, functions, etc.), completeness, basics of metric spaces, convergence, compactness, and spaces of continuous functions. Emphasis will squarely be on constructing sound mathematical arguments, i.e., proofs.

Prerequisites: A grade of C or better in Math 301 (Introduction to Mathematical Reasoning), or an equivalent class (on "Introduction to Proof Writing").

Organization and Grading

There will be **around eleven** homework assignments. Each assignment will be posted at least one week before the day on which it will be due. Discussion of homework problems with other students is allowed and encouraged. But each person should submit their own hand- or type-written solutions.

There will be two exams—a midterm and a final. The dates are provided in the tentative schedule. Both will be given as take home exams. More details will be provided closer to the exams.

The total score for the course will be assigned using the following weights.

- Homework: 60 %
- midterm: 20 %
- final: 20 %

The least homework grade **from among those turned in** will be dropped.

For all graded work, you will be evaluated on

$\Rightarrow$ how well you understood the underlying mathematical concepts,

$\Rightarrow$ whether you correctly applied the concepts to come up with correct arguments/proofs, and

$\Rightarrow$ whether you provide correct and clear **exposition** and description of the above aspects, and of the responses sought in the case of each problem.

Grades for the course will be assigned according to the following scale for the total scores obtained in the course. $\geq$92: A; 88–91.9: A$-$; 83–87.9: B$+$; 78–82.9: B; 73–77.9: B$-$; 68–72.9: C$+$; 63–67.9: C; 58–62.9: C$-$; 53–57.9: D$+$; 45–52.9: D; and $\leq$44.9: F.

Attendance Policy: I will not be recording your attendance. At the same time, it is essential to not miss any of the lectures if you want to do well in this course. As such, you are strongly encouraged to attend class regularly.

Academic Integrity: I encourage discussion of homework problems with others. But each person should submit their own (hand or type) written solutions. You might search the internet for finding materials to enhance your understanding. If you use such material to assist in your homework submission, you **should** cite the relevant sources. Plagiarism or cheating will **not** be tolerated. In particular, do not copy blindly from internet sources! Such behavior is easy to detect, and will result in a zero grade for a graded item and possibly a failing grade for the entire course.

Students with Disabilities: Reasonable accommodations are available for students with a documented disability. All accommodations **MUST** be approved by the Access Center. You are also welcome to discuss you access issues with me, but I will send you to the Access Center ultimately in most cases.

For information on the following WSU policies, please see the University Syllabus. Students are responsible for reading and understanding all university-wide policies and resources pertaining to all courses provided on this web page.

- **Reasonable Accommodations**
- **Arrangements for Religious Reasons**
- **Emergencies on Campus (including active shooter and severe weather)**
- **Student Support Resources (including Student Care Network and Campus Resources and Support)**

Tentative Schedule, and Topics Covered

We will cover sections from Chapters 1–4 from the book LSIRA (Lindstrøm: Spaces An Introduction to Real Analysis). Sections from LSIRA are listed. Based on how things progress, I may cover other topics not listed here (from LSIRA, or outside). Information and materials (handouts, etc.) will be provided in due course if I cover topics outside of LSIRA.

Week	Lec #	Date	Details
1	1	Tue, Aug 19	syllabus, etc. proofs (1.1)
	2	Thu, Aug 21	sets (1.2), families of sets (1.3)
2	3	Tue, Aug 26	functions (1.4), relations (1.5)
	4	Thu, Aug 28	relations (1.5) **[HW 1 Due]**
3	5	Tue, Sep 2	countability (1.6), ϵ-δ arguments (2.1)
	6	Thu, Sep 4	ϵ-δ stuff (2.1), completeness (2.2) **[HW 2 Due]**
4	7	Tue, Sep 9	completeness (2.2), *-value, BW theorems (2.3)
	8	Thu, Sep 11	*-value, BW theorems (2.3) **[HW 3 Due]**
5	9	Tue, Sep 16	metric spaces: definitions (3.1)
	10	Thu, Sep 18	convergence (3.2) **[HW 4 Due]**
6	11	Tue, Sep 23	open and closed sets (3.3)
	12	Thu, Sep 25	complete spaces (3.4) **[HW 5 Due]**
7	13	Tue, Sep 30	more on complete spaces (3.4)
	14	Thu, Oct 2	catch up; review for mid-term
8	15	Tue, Oct 7	**Midterm: Due by 10 PM**
	16	Thu, Oct 9	compact sets (3.5)
9	17	Tue, Oct 14	compact sets (3.5), compactness (3.6)
	18	Thu, Oct 16	completion of metric spaces (3.7) **[HW 6 Due]**
10	19	Tue, Oct 21	modes of continuity (4.1) and convergence (4.2)
	20	Thu, Oct 23	convergence (4.2), calculus with sequences (4.3) **[HW 7 Due]**
11	21	Tue, Oct 28	calculus with sequences (4.3), power series (4.4)
	22	Thu, Oct 30	power series (4.4), bounded function spaces (4.6) **[HW 8 Due]**
12	23	Tue, Nov 4	bounded function spaces (4.6)
	24	Thu, Nov 6	bounded continuous function spaces (4.5) **[HW 9 Due]**
13		Tue, Nov 11	*No class; Veterans Day*
	25	Thu, Nov 13	applications to differential equations (4.7) **[HW 10 Due]**
14	26	Tue, Nov 18	applications to differential equations (4.7)
	27	Thu, Nov 20	compact sets of continuous functions (4.8) **[HW 10 Due]**
		Tue, Nov 25	*No class; thanksgiving*
		Thu, Nov 27	*No class; thanksgiving*
15	28	Tue, Dec 2	more differential equations (4.9)
	29	Thu, Dec 4	Weierstrass' theorems (4.10, 4.11) **[HW 11 Due]**
16		Tue, Dec 9	**[Final Exam] due by 10 PM**

Student Learning Outcomes and Assessment

A student completing this course will achieve the following learning goals.

- **Depth, breadth, and integration of learning:**
  - Develop a thorough understanding of basic concepts from the field of mathematics of **real analysis**.
  - Develop skills and aptitude to construct mathematically sound proofs for basic and some advanced results in real analysis.

- **Creative and Critical thinking:**
  - **Acquire** the necessary **competencies** for **solving mathematical problems** in real analysis. This goal would often require the **innovative use** of the fundamental mathematical concepts for constructing proofs.
  - Be able to **critically evaluate** the relative merits of various relevant approaches to solve problems in real analysis, e.g., different proofs for a result on metric spaces or continuity of functions.

- **Quantitative Reasoning:**
  - Acquire the skills to **construct mathematically sound proofs** for results in real analysis. Become well versed in assessing the correctness of such proof arguments.
  - Acquire the skills to **test** the relevant **assumptions** based on which the various results in real analysis are presented.

- **Communication skills (written and oral):**
  - Provide sound mathematical arguments including proofs in the homework assignments.
  - Participate in discussion during lecture in class.

Most of these goals will be assessed in an integrated fashion throughout the course. Relevant activities for the **assessment** of specific learning goals are tabulated below. **Evaluation** of each learning goal will be performed through **grading** the homework assignments and exams.

Learning goal	relevant activities
Depth, breadth, and integration of learning	all lectures, homework, exams
Information literacy	all homework, exams
Creative and critical thinking	all homework, exams
Quantitative reasoning	proof problems in homework, exams
Communication skills (written)	homework submissions, exams
Communication skills (oral)	in-class participation