About the Course: This course is a rigorous introduction to real analysis of several variables. Topics include analysis on metric spaces, Fourier series, several variable differential calculus and a brief introduction to Lebesgue measure and Lebesgue integration.

Course Prerequisites: Math 425/525 A or permission from the instructor.

Course Format and Teaching Methods: This course consists of regular lectures with in-class discussions.

Course Objectives: This course is the second part of a two-semester, senior-level sequence on advanced calculus, which is required for the comprehensive, probability/statistics, and economics/finance tracks of our major in mathematics. The second semester starts with metric spaces and then discusses continuous functions on metric spaces, convergence, several variables differential calculus, Lebesgue measure and Lebesgue integration.

Expected Learning Outcomes: The course is a rigorous introduction to analysis, and one of the most challenging undergraduate courses we teach. It is also a highly theoretical one. In this course you will be encouraged to think about concepts deeply, be able to create examples to illustrate such concepts, write down precise definitions of these concepts, and then prove various properties concerning these concepts. By the end of this course, students with a grade of B or higher will be ready to take analysis at the graduate level.

Instructor: Dr. Minh Kha, Math Bldg Rm 305, minhkha@math.arizona.edu

Office Hours: Monday from 9am - 9:50am, Wednesday from 9am - 9:50am in Math 305. Tuesday from 11am - 12pm in Math 220. Also by appointment.

Teaching Assistant: Thomas Doehrman, thomasdoehrman@math.arizona.edu. Office hour: Tuesday, 1:00 pm - 2:00 pm in ENR2 N270AA.

Course website/D2L site: https://d2l.arizona.edu

Time and place: MWF 10-10:50am, PSYCH 204

Course text: Analysis II, Third Edition by Terence Tao, Text and Readings in Mathematics 38, Hindustan Book Agency 2014 (Required). An online version of this textbook is available on UofA library website. There are many other excellent introductory analysis books. Reading from other sources is always very valuable. I recommend two other books: Introduction to Real Analysis, by William F. Trench (2013). Books and Monographs. Book 7. http://digitalcommons.trinity.edu/mono/7/, and The way of analysis by Robert S. Strichartz. For more comprehensive references about Lebesgue theory, the two books An introduction to measure theory by Terence Tao and The elements of Integration and Lebesgue Measure by Robert G. Bartle are valuable and accessible.

Calculation of Course Grades: For students enrolled in Math 425B, each midterm exam will be worth 100 points and the final exam will count for 200 points. Homework will be assigned weekly. Homework will count for a total of 200 points. For Math 525B, the grading scheme and requirements will be identical, except that one additional problem will be assigned in each exam. You are encouraged to discuss the homework with each other, but you should attempt the problems first on your own. You learn mathematics by doing, and there is no way around it. If it is not enough to see your teacher or your friends solving problems, you have to try it yourself.

So, for students enrolled in Math 425/525B, the various components of the course grade will be weighted as follows:
<table>
<thead>
<tr>
<th>Semester</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midterm Exams</td>
<td>$2 \times 100$ pts = 200 pts</td>
</tr>
<tr>
<td>Final Exam</td>
<td>200 pts</td>
</tr>
<tr>
<td>Homework</td>
<td>200 pts</td>
</tr>
<tr>
<td>Total</td>
<td>600 pts</td>
</tr>
</tbody>
</table>

Course grades will be calculated based on the following scale:

- 90-100% A
- 80-89% B
- 70-79% C
- 60-69% D
- Below 60% E

**Midterm Exams:** Friday, February 15th, and Monday, April 1st.

**Final Exam:** Friday, May 3rd, 10:30am-12:30pm.

University rules relating to final examinations, and the university final exam schedule may be found at:

[http://www.registrar.arizona.edu/schedules/finals.htm](http://www.registrar.arizona.edu/schedules/finals.htm)

**Missed Exam Policy:** Students who are unable to attend an exam should notify their instructor as soon as possible. Arrangements for a make-up test will be considered on a case-by-case basis. Make-up exams will be administered only at the discretion of the instructor. If a student is allowed to make up a missed exam, the student must take it at a mutually arranged time. No further opportunities will be extended. Failure to contact the instructor as stated above will result in a grade of zero on the exam.

**Homework and Classwork Policies:** Homework will be graded using the same scale as is listed under “grading policies.” Although discussion of homework problems with other students and with the instructor is encouraged, students should write up their own answers. Homework submitted must be a reflection of the students own knowledge, not another students knowledge or the knowledge of someone who posted a solution online. It is important that you understand why that answer is correct, and how you would go about it if you had to do the problem on your own. Homework should be typed in LaTeX or written in legible, complete sentences, showing calculations and reasoning in a clear, logical order. Homework is due at the beginning of class. You must submit your hardcopy homework. Late homework will not be accepted.

In addition, groups of 3 students will be assigned to type up a solution (by LaTeX) that will be graded.

**Grading Disputes:** Any grading disputes must be addressed within one week after an exam or homework has been returned.

**Withdrawal and Incompletes:** A student may withdraw from the course with a deletion from record through Tuesday, January 22nd, using UAccess. A student may withdraw with a grade of “W” through Tuesday, March 26th, using UAccess. A grade of “I” (Incomplete) will be given only at the instructors discretion, according to University Policy as described at

[http://www.registrar.arizona.edu/gradepolicy/incomplete.htm](http://www.registrar.arizona.edu/gradepolicy/incomplete.htm)

**Absence and Class Participation Policy:** Participating in the course and attending lectures and other course events are vital to the learning process. As such, attendance is required at all lectures and discussion section meetings. Absences may affect a student’s final course grade. If you anticipate being absent, are unexpectedly absent, or are unable to participate in class online activities, please contact me as soon as possible. To request a disability-related accommodation to this attendance policy, please contact the Disability Resource Center at (520) 621-3268 or drc-info@email.arizona.edu If you are experiencing unexpected barriers to your success in your courses, the Dean of Students Office is a central support resource for all students and may be helpful. The Dean of Students Office is located in the Robert L. Nugent Building, room 100, or call 520-621-7057.

If you need to miss class for unavoidable circumstances, contact your instructor as soon as possible. Please note the following: All holidays or special events observed by organized religions will be honored for those students who indicate affiliation with that particular religion.
Absences pre-approved by the UA Dean of Students (or Deans designee) will be honored.

It is the student’s responsibility to notify the instructor in advance of an absence related to religious observation or an activity for which a Deans excuse has been granted, and to arrange for how any missed work will be handled.

**Communication with Students:** Announcements and important course information may be sent out via official University email or through D2L. It is the students responsibility to check for messages and announcements regularly.

**Accessibility and Accommodations:** At the University of Arizona we strive to make learning experiences as accessible as possible. If you anticipate or experience barriers based on disability or pregnancy, please contact the Disability Resource Center (520-621-3268, [https://drc.arizona.edu/](https://drc.arizona.edu/)) to establish reasonable accommodations.

Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable.

**Academic Integrity:** Students are responsible to inform themselves of University policies regarding the Code of Academic Integrity. Students found to be in violation of the Code are subject to penalties ranging from a loss of credit for work involved to a grade of E in the course, and risk possible suspension or probation. The Code of Academic Integrity will be enforced in all areas of the course, including, but not limited to, homework, quizzes, and tests. For more information about the Code of Academic Integrity policies and procedures, including information about your rights and responsibilities as a student, see the following website:

[http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity](http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity)

**Student Code of Conduct:** Students at The University of Arizona are expected to conform to the standards of conduct established in the Student Code of Conduct. Prohibited conduct includes: All forms of student academic dishonesty, including cheating, fabrication, facilitating academic dishonesty, and plagiarism. Interfering with University or University-sponsored activities, including but not limited to classroom related activities, studying, teaching, research, intellectual or creative endeavor, administration, service or the provision of communication, computing or emergency services. Endangering, threatening, or causing physical harm to any member of the University community or to oneself or causing reasonable apprehension of such harm. Engaging in harassment or unlawful discriminatory activities on the basis of age, ethnicity, gender, handicapping condition, national origin, race, religion, sexual orientation, or veteran status, or violating University rules governing harassment or discrimination.

Students found to be in violation of the Student Code of Conduct are subject to disciplinary action. For more information about the Student Code of Conduct, including a complete list of prohibited conduct, see the following website:

[http://deanofstudents.arizona.edu/accountability/students/student-accountability](http://deanofstudents.arizona.edu/accountability/students/student-accountability)

**Other Relevant University Policies Relating to Conduct:** Please take note of the following University policies:

- Policy on Threatening Behavior by Students:

- Nondiscrimination and Anti-Harassment Policy:

**Expected Classroom Behavior:** Students should turn off all electronic devices during class unless the device is deemed necessary for the class by the instructor. This includes, but is not limited to cell phones,
mp3 players, and laptops. If you have a disability-related accommodation that involves the use of a computer during class, please discuss this with your instructor in advance.

**Changes to the Course Syllabus:** The information contained in the course syllabus, other than the grade and absence policies, may be subject to change with reasonable advance notice, as deemed appropriate by the instructor.

**One more thing...**

I am excited to have the chance to teach this class this semester. If there is anything I can do to help you succeed in this course or make it more enjoyable, please e-mail me or drop by and share what’s on your mind.
Scheduled Topics/Activities

I strongly recommended that you read the textbook concurrently with the lectures (not just only when you need to do your homework!). Note that the depth of the material is such that you are unlikely to keep up just by attending lectures. It is important that you work all the homework, especially because many of the homework questions cover essential material.

Below is a tentative syllabus. Topics covered on a given day may change, but dates of tests will not be modified.

- **Week 1**
  - Wednesday, January 9: Welcome; course syllabus and policies. Metric spaces; examples.
  - Friday, January 11: Convergent sequences in metric spaces.
- **Week 2**
  - Monday, January 14: Basic point-set topology of metric spaces.
  - Wednesday, January 16: Relative topology. Due HW1
  - Friday, January 18: Cauchy sequences and complete metric spaces.
- **Week 3**
  - Monday, January 21: Martin Luther King Jr Holiday - no classes / office hours.
  - Wednesday, January 23: Compact metric spaces. Due HW2
  - Friday, January 25: Continuous functions on metric spaces.
- **Week 4**
  - Monday, January 28: Continuity and product spaces.
  - Wednesday, January 30: Continuity and compactness. Due HW3
  - Friday, January 31: Uniform convergence, and continuity.
- **Week 5**
  - Wednesday, February 6: Uniform approximation by polynomials - Part I. Due HW4
  - Friday, February 8: Uniform approximation by polynomials - Part II.
- **Week 6**
  - Monday, February 11: A digression on complex numbers.
  - Wednesday, February 13: Special functions: exponential and trigonometric functions Due HW5
  - Friday, February 15: Exam 1.
- **Week 7**
  - Monday, February 18: Inner products on periodic functions.
  - Wednesday, February 20: Trigonometric polynomials - Part I. Due HW6
  - Friday, February 22: Trigonometric polynomials and Weierstrass's theorem - Part II.
- **Week 8**
  - Wednesday, February 27: Linear transformations - Part I. Due HW7
– Friday, March 1: Linear transformations - Part II.

● Week 9  Spring Break

● Week 10
– Monday, March 11: Derivatives in several variable calculus.
– Wednesday, March 13: Partial and directional derivatives.  Due HW8
– Friday, March 15: The several variable calculus chain rule.

● Week 11
– Monday, March 18: Double derivatives and Clairaut’s theorem.
– Wednesday, March 20: The contraction mapping theorem.  Due HW9
– Friday, March 22: The inverse function theorem - Part I.

● Week 12
– Monday, March 25: The inverse function theorem - Part II.
– Wednesday, March 27: The implicit function theorem.  Due HW10
– Friday, March 29: Introduction to Lebesgue measure and sigma algebras

● Week 13
– Monday, April 1: Exam 2.
– Wednesday, April 3: Outer measure - Part I.  Due HW11
– Friday, April 5: Outer measure - Part II.

● Week 14
– Monday, April 8: Measurable sets - Part I.
– Wednesday, April 10: Measurable sets - Part II.  Due HW12
– Friday, April 12: Measurable functions, Simple functions - Part I.

● Week 15
– Monday, April 15: Measurable functions, Simple functions - Part II.
– Wednesday, April 17: Measurable functions, Simple functions - Part III.  Due HW13
– Friday, April 19: Integrations of non-negative measurable functions - Part I.

● Week 16
– Monday, April 22: Integrations of non-negative measurable functions - Part II.
– Wednesday, April 24: Integrations of absolutely integrable functions - Part I.  Due HW14
– Friday, April 26: Integrations of absolutely integrable functions - Part II.

● Week 17
– Monday, April 29: Comparison with the Riemann integral.
– Wednesday, May 1: Fubini’s theorem. Review for final exam.  Due HW15
– Friday, May 3, 10:30am-12:30pm: Final Exam.