Math 6320. Real Variables (13175 and 28138). Fall Semester 2020.

Time and Place: 11-12 am MWF on Teams (for face-to-face times contact me).
Instructor: Dr. David Blecher.
Office Hours: 12-1 pm MF (in the Office hours channel on Teams; we can also do a Zoom meeting by request). classroom, or email me for an appointment.
Email: dpbleche@central.uh.edu
Final exam: During exam week at the assigned time, or at a time convenient to all.
Text: Instructors class notes.
TA/Grader/Tutoring hour: To be announced.
Other recommended texts (optional):
Real Analysis: Modern Techniques and Their Applications, 2nd Edition, by: Gerald B. Folland
F. Jones, "Lebesgue integration on Euclidean spaces", Jones and Bartlett.
H. L. Royden, Real Analysis (3rd Edition), Prentice Hall.
W. Rudin, Real and Complex Analysis, Mc.Graw Hill.
D. L. Cohn, Measure Theory, Birkhauser.
Prerequisites: An undergraduate real analysis sequence (e.g. Math 4331,4332, or consent of the instructor). Some topology and metric spaces would be useful. Probably an important prerequisite is an enjoyment of, and talent for, abstract mathematical concepts and systematic abstract logical reasoning.

This is the first semester of a 2 semester sequence. This semester we will be developing the basic principles of measure and integration. This body of knowledge is essential to most parts of mathematics (in particular to analysis and probability) and falls within the category of "What every graduate student has to know". The one test and the final exam will be based on the notes given in class, and on the homework. After each chapter we will schedule a problem solving workshop, based on the homework assigned for that chapter. The most important part of your task as a graduate student in this course is simply to reread the typed class notes making sure you understand everything. You are expected to read and digest the typed notes, line by line, trying to follow why the line is true, for example how it follows from previous lines. I suggest you add a check mark after you have read and understood the line, add extra explanation or pictures to yourself if needed. Add a question mark next to any line you cannot follow, and ask me about it. Also memorize 'definitions' as you read. The best advice I can give to ensure success in this class is to do this reading properly. In my experience, the class becomes much much more difficult if you do not do it. It takes a long time to do this, and this kind of detailed reading is not without pain, but it will help reconfigure your brain to internalize the kind of logic/thinking/proof skills that are needed in this subject (and in most other graduate courses). Also important is the assigned homework, a collection of problems which are all worth trying, and some of which are important. You should attempt (almost) all homework problems. Some of them are difficult, others are easy. Their purpose is to help you learn and internalize the material and techniques, or to touch on an aspect we don't have time in class for. You are encouraged to work with others, form study groups, and so on; however do not simply copy homework unless you've tried hard to do the problem. Never copy homework you are required to turn in.

Although some of our classes will be regular lectures online, because of the difficulties of learning a very deep theoretical subject online we will often adopt a 'flipped classroom' format. The aim is to make the class most effective in this online format for the largest number of students in the class, so please do share your ideas with me about what works for you and what does not. 'Flipped classroom' for us means in part that some days you will do a reading of a stretch of the Class notes before class,

which we will discuss in class. Each student will have to present a proof to the class once every week or two. We also will discuss homework problems in class. And in class when discussing or others are presenting be willing to share thoughts, feelings, and ideas, in the spirit of a flipped classroom!

Due to the changing nature of the COVID-19 pandemic, please note that the instructor may need to make modifications to the course syllabus and may do so at any time. Notice of such changes will be announced as quickly as possible via email and the course website.

Course grade: Your final grade is approximately based on a total score of 430 points consisting of homework, interactive assignments, and quizzes (100 points), in-class presentations/participation (100 points), discussion group (30 points), a semester test (100 points), and a final exam (100 points). Because it is hard to listen to online lectures on advanced material, there will also be occasional interactive assignments or in-class poppers (pop quizzes) intended to help you focus and grasp a significant point that has just been covered–if you need to be excused from class let me know before class so that we can send you any quizzes for that day. These grades will be included in the homework total above. The instructor may change these grade proportions at his discretion; usually this will be so as to benefit the majority of the class, or in case of changes due to COVID etc.

The syllabus for the first semester will cover some but not all of the following topics:

Measures. Measurable functions. Integration. Convergence of sequences of functions. The L^p spaces. Intro to Hilbert spaces. Signed and complex measures. Product measures and Fubini's theorem. Differentiation and integration.

You do not need to buy a text, instructor will supply any background notes needed. Here are some recommended background texts: 1) Frank Jones, "Lebesgue integration on Euclidean spaces," Jones & Bartlett. 2) H. L. Royden, Real Analysis (3rd Edition), Prentice Hall. 3) W. Rudin, Real and Complex Analysis, Mc.Graw Hill. 4) D. L. Cohn, Measure Theory, Birkhauser.

This semester we will be continuing to develop the basic principles of measure, integration, and linear analysis. This body of knowledge is essential to many parts of mathematics (in particular to analysis and probability).

In the second semester we will cover the following topics, and perhaps some others: Signed and complex measures. The Radon-Nikodym theorem. The duality of L^p spaces. Differentiation and integration of measures and functions on R^n. Basic connections with probability theory (distributions, density, independence). The Riesz representation theorem. Banach and Hilbert spaces. Basic principles of linear analysis. Fourier transform, convolutions, etc.

After each chapter we will schedule a problem solving workshop, based on the homework assigned for that chapter.

The one test and final exam exam will be based on the notes given in class, and on the homework. It is essential to have good class notes. The syllabus is quite long.

You should attempt all homework problems, although it is not expected that you solve all of them. Most of the problems are there to help you learn and INTERNALIZE the material. Remember that Math is always easy when you look back on it, AFTER you have spent the time wrestling with the new concepts and doing plenty of exercises. No pain, no gain. Some of the homework problems explain or amplify points we did not have time to cover in lectures.

You are encouraged to work with others, form study groups, and so on. However you should not simply copy homework. Please bring comments or complaints to my attention as soon as possible. Don't wait until the end of the semester to bring up a matter which we could deal with and solve

early on. You may find the class structure complicated at first, but it will become clear as we get into it. Always ask, if you are not sure!!

Commit the assigned 11–12 am MWF class time as a dedicated class time period, and put this on your weekly calendars. We meet on Teams (with a video of the live event posted on Blackboard for those unable to attend whenever possible–a technical glitch may make that impossible). Instructions for using Teams are contained in the "Information and Instructions for use of the online tools" link on the main Class page. There will also be poppers (inclass pop quizzes), or other checks that you are actually watching/have watched the lecture, with a grade attached.

Academic Honesty Policy: . In online assignments and tests you will sometimes be asked to make an Academic Honesty/Honor Code statement ("I received no help ...", etc.) It may be OK on certain kinds of assignments to use something you found on the internet, as long as you cite your link, come to a full understanding of it, and explain it in your own words. You are encouraged to work with others on homework or problems to be presented in class, form study groups, and so on, however copied turned in homework will not help you assimilate the material, and will not be graded. So if you work in a group write up the solutions on your own, and not as a group. University of Houston students are expected to adhere to the UH Academic Honesty Policy (google UH Academic Honesty Policy). "Academic dishonesty" means employing a method or technique or engaging in conduct in an academic endeavor that contravenes the standards of ethical integrity expected at the University of Houston or by a course instructor to fulfill any and all academic requirements. Academic dishonesty includes, but is not limited to, the following: Plagiarism; Cheating and Unauthorized Group Work; Fabrication, Falsification, and Misrepresentation; Stealing and Abuse of Academic Materials; Complicity in Academic Dishonesty; Academic Misconduct. Refer to UH Academic Honesty website (http://www.uh.edu/provost/policies/honesty/) and the UH Student Catalog for the definition of these terms and university's policy on Academic Dishonesty. Anyone caught cheating will be reported to the department for further disciplinary actions, receive sanctions as explained on these documents, and will have an academic dishonesty record at the Provosts office. The sanctions for confirmed violations of this policy shall be commensurate with the nature of the offense and with the record of the student regarding any previous infractions. Sanctions may include, but are not limited to: a lowered grade, failure on the examination or assignment in question, failure in the course, probation, suspension, or expulsion from the University of Houston, or a combination of these. Students may not receive a W for courses in which they have been found in violation of the Academic Honesty Policy. If a W is received prior to a finding of policy violation, the student will become liable for the Academic Honesty penalty, including F grades.

Communication and feedback: Communication between you and the instructor is by email to your official UH Exchange email address, and by postings by the red flashing light on the class website, etc. Exchange email accounts can be accessed by logging into Office 365 with your Cougarnet credentials or through Acccess UH. They can also be configured on IOS and Android mobile devices. There may also be announcements via Blackboard or Teams. Instructor will not respond to Teams chat messages or video calls outside of class and of office hours. Please be sure that you are regularly getting and seeing your email to your official UH email address, since the instructor will largely communicate with the class by email like this. UH policy states that all required written notices shall be addressed to the student via their UH email. Notices properly addressed and so sent shall be presumed to have been received by the student. Thus, you are responsible for the content in emails sent to your UH account, regardless if your external (non-UH) email provider filters or blocks them. Emails lost to external providers shall not be used as a justification to claim faculty

are unresponsive, to appeal grades, etc.

Bring comments or complaints to my attention as soon as possible. Don't wait until the end of the semester to bring up a matter which we could deal with and solve early on.

Instructions for presentations: Prepare your presentation in plenty of time. You will be given the material to present days in advance, and can bring me any questions on it beforehand. Email me a copy to me of your write-up no later than 24 hours before your presentation. Keep a copy for your records. I will check your work for errors, and may make some suggestions before the class. In the case that an assigned presenter has to miss class at the last moment please ask another person in the class to present, or ask the instructor to present it (but do be sure to send the pdf of the solution 24 hours earlier as usual). If this does not happen and there is no presenter of a particular problem and no pdf of the solution sent to the instructor in advance, then you will lose presentation points. The instructor will keep a list of those who present; students not presenting regularly will lose all presentation points at the end of the semester (unless you have a medical reason, etc).

Instructions for writing your presentations: Begin by writing the statement of the result you are presenting. Write big! And neatly and legibly, or type. Draw a picture(s) if possible. It would help others if you highlight the key points by putting them in a box. Write your initials but do not write your student number or any other personal information you do not want to share on your pdf.

And in class when others are presenting... be willing to share thoughts, feelings, and ideas, in the spirit of a flipped classroom!

Attendance: Attendance of all class meetings is expected, but we also realize that because of the Covid crisis or other life events there may be times some of you simply have to miss class. Coming to class you will hear a lot of math 'culture', how we think about a result or problem, how to think through computations, how to express your answers, and so much more. If you do not come to class or pay attention you are missing out on a lot of very important conscious and subconscious learning and culture. This is a synchronous class. Many synchronous classes are designed to incorporate interactive classroom activities for students, indeed studies show that such activities can greatly facilitate learning. Thus students treating a synchronous class as if it were asynchronous in terms of 'live' attendance may be at a real disadvantage at times. If you do miss a class please let me know, so that if there are popper questions that day I can give them later, perhaps informally as an oral exam on Teams, etc. You will need an university recognized excuse, eg. doctors note, for important class occasions such as tests which you are forced to miss.

Class calendar events/Upcoming assignments may be found by the red flashing light on the class website. You will usually be emailed about these too.

Homework: You will turn in homework as a PDF on Blackboard.

Equipment or apps you will need: See "Information and instructions for use of the online tools" link on the main Class page. E.g. access to a webcam is required for students participating remotely in this course. Webcams must be turned on during exams to ensure the academic integrity of exam administration.

Tests and Test policies: Tests will be taken online on Courseware/CASA– you will have to upload a pdf of your answers. You will be informed in advance how to access your test. Corrections

to grading errors should be brought to my attention in a timely manner. Please bring your student ID, but no calculators, to tests and exams.

Makeup tests: If you miss a test give me a doctors note or the like (an acceptable documented excuse or university approved absence) within 2 days of the missed test, to qualify to take a makeup. The makeup will probably not be the same test, and it might be an oral examination.

Incompletes: only given to students passing the class on the work during the semester, who are unable to take the Final for unforseeable, unpreventable, documented circumstances. See also the next item.

Excused Absence Policy : Regular class attendance, participation, and engagement in coursework are important contributors to student success. Absences may be excused as provided in the Graduate Excused Absence Policy at `https://uh.edu/provost/policies-resources/student/excused-absence-policy/index.php` for reasons including: medical illness of student or close relative, death of a close family member, legal or government proceeding that a student is obligated to attend, recognized professional and educational activities where the student is presenting, and University-sponsored activity or athletic competition. Additional policies linked there address absences related to military service, religious holy days, pregnancy and related conditions, and disability. Eg. Students whose religious beliefs prohibit class attendance or the completion of specific assignments on designated dates may obtain an excused absence.

Recording of Class policy: Students may not record all or part of class, livestream all or part of class, or make/distribute screen captures, without advanced written consent of the instructor. If you have or think you may have a disability such that you need to record class-related activities, please contact the Center for Students with DisABILITIES. If you have an accommodation to record class-related activities, those recordings may not be shared with any other student, whether in this course or not, or with any other person or on any other platform. Classes may be recorded by the instructor. Students may use instructor's recordings for their own studying and notetaking. Instructor's recordings are not authorized to be shared with anyone without the prior written approval of the instructor. Failure to comply with requirements regarding recordings will result in a disciplinary referral to the Dean of Students Office and may result in disciplinary action.

Resources for Online Learning: The University of Houston is committed to student success, and provides information to optimize the online learning experience through our Power-On website `https://uh.edu/power-on/learning/`. Please visit this website for a comprehensive set of resources, tools, and tips including: obtaining access to the internet, AccessUH, and Blackboard; requesting a laptop through the Laptop Loaner Program; using your smartphone as a webcam; and downloading Microsoft Office 365 at no cost. For questions or assistance contact UHOnline@uh.edu

CSD Accommodations: Academic Adjustments/Auxiliary Aids: The University of Houston System complies with Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Actof 1990, pertaining to the provision of reasonable academic adjustments/auxiliary aids for students who have a disability. In accordance with Section 504 and ADA guidelines, University of Houston strives to provide reasonable academic adjustments/auxiliary aids to students who request and require them. If you believe that you have a disability requiring an academic adjustments/auxiliary aid, please visit The Center for Students with DisABILITIES (CSD) website at http://www.uh.edu/csd/ for more information. Accommodation Forms: Students seeking academic adjustments/auxiliary aids must, in a timely manner (usually at the beginning of the semester),

provide their instructor with a current Student Accommodation Form (SAF) from the CSD office before an approved accommodation can be implemented. Additionally, if a student is requesting a (CSD approved) testing accommodation, then the student will also complete a Request for Individualized Testing Accommodations (RITA) paper form to arrange for tests to be administered at the CSD office. CSD suggests that the student meet with their instructor during office hours and/or make an appointment to complete the RITA form to ensure confidentiality.*Note: RITA forms must be completed at least 48 hours in advance of the original test date. Please consult your counselor ahead of time to ensure that your tests are scheduled in a timely manner.

UH CAPS Statement: Counseling and Psychological Services (CAPS) can help students who are having difficulties managing stress, adjusting to college, or feeling sad and hopeless. You can reach CAPS (www.uh.edu/caps) by calling 713-743-5454 during and after business hours for routine appointments or if you or someone you know is in crisis. No appointment is necessary for the "Let's Talk" program, a drop-in consultation service at convenient locations and hours around campus: `https://www.uh.edu/caps/outreach/lets-talk/index.php#hours`

HyFlex vs Synchronous Online: This course is offered both as a HyFlex Course and Synchronous Online. If you are attending as a HyFlex course you must obtain my permission to do so, and transfer the class to that format officially (there is a different Section number). Such students will have a designated face-to-face spot reserved, but alternative ways to participate will also be provided. These alternatives may include (but is not limited to) attending class sessions through synchronous streaming. As the University will be transitioning all classes and final exams given after the Thanksgiving Break to online delivery, the exam for this course will be delivered in the synchronous online format, and the specified date and time will be announced during the course.

Synchronous Online Courses have no face-to-face component to this course. In between synchronous class meetings, there may also be asynchronous activities to complete (e.g., discussion forums and assignments).

If you are attending any face-to-face class: 1) Face Covering Policy : To reduce the spread of COVID-19, the University requires face coverings on campus including classrooms for both faculty and students. Face coverings must cover your mouth and nose and be worn throughout the class session. A mask with a valve is not considered an adequate face covering and should not be used, as it can expel exhaled air, increasing the risk to others. Eating or drinking during class is discouraged and is not an excuse for removing the face covering for any extended length of time. For additional information on the use of face coverings, please see `https://uh.edu/covid-19/faq/face-covering-faqs`. Failure to comply with the requirement to wear a face covering in class will result in your being asked to leave the classroom immediately and a disciplinary referral through the Dean of Students Office. Requests for accommodations relating to the face covering policy may be directed to the Center for Students with DisABILITIES (CSD).

2) Required Daily Health Self-Assessment: Your presence in class each session means that you have completed a daily self-assessment of your health/exposure and you a) Are NOT exhibiting any Coronavirus Symptoms, b) Have NOT tested positive for COVID-19, and c) Have NOT knowingly been exposed to someone with COVID-19 or suspected/presumed COVID-19. If you are experiencing any COVID-19 symptoms that are not clearly related to a pre-existing medical condition, do not come to class. Please see https://`www.uh.edu/covid-19/information/covid-19-diagnosis-symptoms-protocols` for what to do if you experience symptoms, and please see `https://www.uh.edu/covid-19/information/potential-exposure-coronavirus/` for what

to do if you have potentially been exposed to COVID-19. Consult the Graduate Excused Absence Policy above for information regarding excused absences due to medical reasons.

3) Comply with the UH social distancing policy. Do not approach the instructor or other students closer than 6 feet at any time during the class. Please ask your questions from your seats.

Helpful Information:

COVID-19 Updates: `https://uh.edu/covid-19/`

Coogs Care: `https://www.uh.edu/dsaes/coogscare/`

Laptop Checkout Requests:
`https://www.uh.edu/infotech/about/planning/off-campus/index.php#do-you-need-a-laptop`

Health FAQs: `https://uh.edu/covid-19/faq/health-wellness-prevention-faqs/`

Student Health Center:
`https://uh.edu/class/english/lcc/current-students/student-health-center/index.php`