GOSHEN COLLEGE
MATHEMATICS DEPARTMENT
MATH 311 REAL ANALYSIS – MAY TERM 2020-21

Description A rigorous study of the real numbers, functions involving real numbers, limits, sums, differentiation, and integration.

Learning Goals By the end of the course, students will do the following.

1. Describe and use real analysis concepts, definitions, and theorems to determine and prove the truth of conjectures.
2. Read, write, present, and converse about mathematics effectively.
3. Learn mathematics independently and collaboratively.

Instructor David Housman, SC 117, dhousman@goshen.edu, 535-7405
Office hours posted on office door and Moodle

Class Time MTWRT 8:00 a.m. – 9:15 a.m. and 11:00 a.m. – 12:15 p.m. in SC 117. Class activities are an extremely important and an integral part of the pedagogy for this course. Attendance and participation are expected. In mathematics, truth is determined by deduction, not decree (with democracy being no better than dictatorship). Students will be asked to present their proofs and are encouraged to critique proofs presented by the instructor and other students.

Textbook *Understanding Analysis* by Stephen Abbott, Springer-Verlag, second edition, 2015. In a review of the first edition, Steve Kennedy said, "This is a dangerous book. *Understanding Analysis* is so well-written and the development of the theory so well-motivated that exposing students to it could well lead them to expect such excellence in all their textbooks. You might not want to adopt this text unless you're comfortable teaching from a book in which the exposition will nearly always be clearer than your lectures." I am hoping everyone will faithfully read the text so that class can focus on solving problems, presenting solutions, and critiquing solutions. We will cover almost the entire text.

On-line https://moodle.goshen.edu

Grading Grades will be based upon assignments (50%), quizzes (15%), class participation (15%), and a final project (20%). A C- grade represents eventual competence in all course content areas (70% minimum on the numerical grade). A B- grade represents mastery in all course content areas (80% minimum on the numerical grade). An A- grade represents mastery and some degree of originality, creativity, and insight (90% minimum on the numerical grade).

Assignments Reading, thinking, problem solving, and writing will be assigned as a follow up to and preparation for every class. I encourage you to discuss the problems with each other, but you should write the solutions by yourself in your own words. I will accept revised work one class day after the graded assignment is returned. Revised work will be given a maximum grade of 70% on a per exercise basis.

Quizzes When learning to be a carpenter, certain facts are memorized (e.g., characteristics of different types of wood, nails, and screws) and certain skills become second-nature (e.g., pounding nails, turning screws, and operating a lathe). To be an effective mathematician, concept definitions and theorems are memorized and standard approaches for proofs become second-nature. In class closed-book quizzes will ask you to state important definitions, theorems, and proofs.

Class Participation Listening to others, presenting your own ideas, asking questions, responding to questions, and facilitating discussion contribute to our collaborative efforts to investigate mathematics. You will be given opportunities to present solutions to assignments and/or present material from the text.

Final Project A mathematician often needs to learn a topic independently or investigate questions for which no one yet has the answer. The final project will provide an experience to strengthen your skills in independent learning and/or investigation. In consultation with you, the instructor will assign you a topic to learn and/or investigate. Typically, this will correspond to a section in the course text, a section in another book, or a journal article. Complete the work suggested by the reading material or negotiated with the instructor. Turn in your written work and give a short presentation of your work during the scheduled final exam period.

Disability Services	Goshen College is committed to providing all students equal access to programs and facilities. Students who need accommodations based on disability should contact the Director of the Academic Success Center (ASC). Students must register with ASC before faculty are required to provide reasonable accommodations. For more information or to register, please contact the Director of the ASC, Judy Weaver, Good Library 112, jweaver@goshen.edu or 574-535-7560. To ensure that learning needs are met, contact the director of the ASC the first week of classes.
Collaboration and Academic Integrity	You are encouraged to use all available resources in order to learn the concepts and techniques discussed in this course. In particular, conversations with other students and the instructor can be an effective learning method. Reading other books and web pages can be another effective learning method. However, copying someone else's work subverts the learning process. For assignments, give written acknowledgement to people with whom you have had discussions and to any written materials (other than the text) that were helpful. For quizzes, you may *not* use any resources unless a specific exception is stated by the instructor. Failure to observe the above rules will result in a penalty ranging from a zero on the assignment or exam to immediate failure of the course. Any violation of academic integrity will be reported to the Academic Dean. Observation of the above rules will help you learn the material well and give you the satisfaction of knowing that you have earned your grade.

Tentative Schedule. Reading is to be done in preparation for the given class during which the specified quiz will be given. Assignments are due at 8:00 a.m. on the next class day after the topic is covered.

Class	Reading	Quiz	Assignment
01	Reals		A01: Theorems 11, 12, 18, 32, 44; 1.2 #1
02	1.1-2	Q02: Function, triangle inequality	A02: 1.2 #3, 5c, 6cd, 7, 11a, 13
03	1.3	Q03: Theorem 1.2.6 & proof	A03: 1.3 #
04	1.4	Q04: Completeness axiom, least upper bound	A04: 1.4 #
05	1.5-7	Q05: One-to-one, onto, same cardinality as	A05: 1.4 #
06	2.1-2	Q06: Prove reals are uncountable	A06: 2.2 #
07	2.3	Q07: Sequence, sequence convergence	A07: 2.3 #
08	2.4-5	Q08: Sequence convergence proof	A08: 2.4 #
09	2.6-7	Q09: Monotone Convergence & Bolzano-Weierstrass Theorems	A09: 2.6 #
10	2.7-9	Q10: Cauchy sequence and Criterion	A10: 2.7 #
11	3.1-2	Q11: series, absolute, and conditional convergence	A11: 3.2 #
12	3.3	Q12: open, limit point, closed, isolated point, closure [20]	A12: 3.3 #
13	4.1-2	Q13: compact, Heine-Borel Theorem	A13: 4.2 #
14	4.3	Q14: simple limit proof	A14: 4.3 #
15	4.4	Q15: prove a function is continuous	A15: 4.4 #
16	4.5	Q16: uniformly continuous	A16: 4.5 #
17	5.1-2	Q17: IVT	A17: 5.2 #
18	5.3	Q18: derivative of a quadratic via the definition	A18: 5.2 #
19	5.4-5	Q19: MVT	A19: 5.3 #
20	6.1-2	Q20: an everywhere continuous and nowhere differentiable function	A20: 6.2 #
21	6.3	Q21: pointwise & uniform convergence	A21: 6.3 #
22	6.4		A22: 6.4 #
23	6.5	Q23: Weierstrass M-Test	A23: 6.5 #
24	7.1-2	Q24: Modified Theorem 6.5.7	A24: 7.2 #
25	7.3	Q25: Riemann integral [30]	A25: 7.3 #
26	7.4		A26: 7.4 #
27	7.5-7		A27: 7.5 #