

ACSI 301: Theory of Interest

2019

Mathematical Interest Theory, Vaaler and Daniel, Chapters 1-9

Financial Mathematics, Solla, Chapters 1-5

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Office hours by appointment at calendly.com/minton/15min

Course Description: An introduction to the mathematical theory of interest. Topics include money growth, investment return, annuities, arbitrage, interest rate sensitivity, and immunization.

Course Objectives: *Learn mathematics used in the actuary profession.* The second test in the actuary field is Exam FM: Financial Mathematics. This tests your knowledge of the basic ways that money is invested, and the ways that investments are evaluated. ACSI 301 prepares you for this test, while covering the basics of financial mathematics including time value of money, annuities, loans, bonds, portfolios, options, and immunizations. (Note: if you're planning to pass Exam FM, you will need to do a lot of extra studying)

Intended Learning Outcomes: At the end of the course, successful students will be able to

- Apply concepts of financial mathematics to calculating present and accumulated values
- Demonstrate proficiency in pricing, asset/liability management, and capital budgeting
- Synthesize partial financial information into a complete financial analysis
- Demonstrate the use of no-arbitrage concepts in financial mathematics
- Demonstrate proficiency of each of the learning objectives at the Society of Actuaries FM webpage

Required Reading:

Mathematical Interest Theory, Vaaler and Daniel

Financial Mathematics, Solla

Equipment: A Texas Instruments BA II Plus calculator or equivalent is highly recommended. The BA II Plus is recommended by the Society of Actuaries for the FM exam.

Attendance Policy: Regular attendance is expected. You must keep up with definitions! You are responsible for everything done in class. If you miss a class, e-mail or call me before class is over and explain why. **If you have two unexplained absences, you will be dropped from the course after a warning email is sent.**

I expect you to spend at least 12 hours of work each week inside and outside of class. You should expect to spend more time on material that is difficult for you.

Academic Integrity: The college policy is fully supported. Tests and are closed notes, closed book. Homework assignments will be discussed in class, and you may always ask me for help. **Do not** collaborate on homework. No electronic devices are allowed in a test situation.

Co-Curricular: During the course of the semester, you must attend at least two approved co-curricular events. There are usually ten or so events in a semester, but do not procrastinate! For each, write a report with (1) a brief summary and (2) a discussion of something that interested you. Due within a week of the event. The event may be a part of the MCSP Conversation Series or an approved event of special interest to ACSI majors.

Study problems and homework: You should attempt as many of the problems in each of the books as possible. Test questions will be modeled on these problems (and Exam FM questions often look like these). In addition, there will be every-other-week homework assignments on problems based on these book problems. Start on these problems early and ask questions!

Tests: We will use the mastery testing method. There will be 26 topics to master. Grading of a problem will be either Mastered or not – no partial credit. You may re-try topics that you did not master previously without penalty. Once you have mastered a topic you do not have repeat that topic. Your overall test/exam grade will be based upon how many topics you master – see the grading scale below. There will be six full test days, with other opportunities in class to repeat topics. On full test days, the first half of the time is devoted to new topics. **Do not plan on falling behind!** Please note that you do not have an infinite set of testing opportunities. We will talk about strategy and status in the course at various times during the semester – the most important message is to keep working and studying! The exam is Thursday, April 25, 2:00-5:00.

Make-ups: In case of sickness or scheduling conflicts, get in touch with me ASAP.

Grading: Homework and co-curricular count 30%. The exam and tests count 70% of the final average. Grades may be curved up based on extenuating circumstances.

A: 93-100 A-: 90-92 B+: 87-89 B : 83-86 B-: 80-82 C+: 77-79 C: 73-76 C-: 70-72
D+: 67-69 D: 63-67 D-: 60-62 F: 59 and below

Special Needs: located in the Goode-Pasfield Center for Learning and Teaching in Fintel Library. Accommodations are provided based on the diagnosed disability and the recommendations of the professional evaluator. In order to be considered for disability services, students must identify themselves to the Office of Accessible Education Services. Students requesting accommodations are required to provide specific current documentation of their disabilities. Please contact Accessible Education Services, at 540-375-2247. If you are on record with Accessible Education Services as having academic or physical needs requiring accommodations, please schedule an appointment with Accessible Education Services soon. You need to discuss your accommodations before they can be implemented. Also, please note that arrangements for extended time on exams, testing, and quizzes in a distraction-reduced environment must be made at least one week *before every exam*.

Topics:

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|--------------------------|----------------------------|
| 1. Basic Interest | 15. Level Annuities |
| 2. Discount Functions | 16. Amortized Loans |
| 3. Compound Rates | 17. Sinking Fund |
| 4. Nominal Rates | 18. Replacement of Capital |
| 5. Force of Interest | 19. Bond Prices |
| 6. Time Value of Money | 20. Bond Amortization |
| 7. Equations of Value | 21. Callable Bonds |
| 8. Investment Return | 22. Brokerage Accounts |
| 9. Yield Rates | 23. Arbitrage |
| 10. Fund Performance | 24. Commodity Futures |
| 11. Annuities | 25. Price Options |
| 12. Deferred Annuities | 26. Derivative Instruments |
| 13. Loan Balances | |
| 14. Annuity Progressions | |

Grading Scale: Master x topics, grade is $22 + 3x$ (e.g., master 13 of 26, grade is 61)

Date	Topic	Sections	Notes
1/14	Simple Interest	Vaaler 1.3	
1/16	Compound Interest	Vaaler 1.4,1.5	
1/18	No class		Homework #1 due
1/21	Discount Functions	Vaaler 1.6,1.7	
1/23	Compound discount	Vaaler 1.8,1.9	
1/25	Nominal Rates	Vaaler 1.10	Homework #2 due
1/28	Force of Interest	Vaaler 1.11,1.12	
1/30	TEST #1	Topics 1-4	
2/1	Time Value of Money	Solla chapter 2	
2/4	Equations of Value	Vaaler 2.2,2.3	
2/6	Investment Return	Vaaler 2.4,2.5	

Date	Topic	Section	Notes
2/8	Yield Rates	Vaaler 2.6	Homework #3 due
2/11	Fund Performance	Vaaler 2.7	
2/13	TEST #2	Topics 5-9	
2/15	Annuities	Vaaler 3.2,3.3	
2/18	Deferred Annuities	Vaaler 3.4,3.5	
2/20	Loan Balances	Vaaler 3.6,3.7	
2/22	Geometric Progression	Vaaler 3.8	Homework #4 due
2/25	Arithmetic Progression	Vaaler 3.9	
2/27	Financial Instruments	Solla chapter 3	
3/1	TEST #3	Topics 10-14	

Date	Topic	Section	Notes
3/11	Level Annuities	Vaaler 4.2,4.3	
3/13	Amortized Loans	Vaaler 5.2	
3/15	Sinking Fund	Vaaler 5.3,5.4	Homework #5 due
3/18	Replacement of Capital	Vaaler 5.5	
3/20	Bonds	Vaaler 6.2	
3/22	TEST #4	Topics 15-18	
3/25	Bond Pricing	Vaaler 6.3,6.4	
3/27	Bond Amortization	Vaaler 6.5	
3/29	Callable Bonds	Vaaler 6.7,6.9	Homework #6 due

Date	Topic	Section	Notes
4/1	Brokerage Accounts	Vaaler 7.1,7.2	
4/3	Arbitrage	Vaaler 8.2,8.3	
4/5	TEST #5	Topics 19-22	
4/8	Commodity Futures	Vaaler 8.5,8.6	
4/10	Options	Vaaler 8.7,8.8	Homework #7 due
4/12	Derivative Instruments	Solla Chapter 4	
4/15	Asset-Liability Mgt	Solla Chapter 5	
4/17	TEST #6	Topics 23-26	
4/19	Good Friday		
4/22	Immunization	Vaaler 9.4	

FINAL EXAM: Thursday 4/25, 2:00-5:00

Model Reflection Paper

(This is made up, but shows what I'd like to get from you. The two main elements are (1) brief summary of talk and (2) some original thought on the subject.)

The talk on September 7th was by Dr. Sue Dokoo of Pseudo Duke University. Her research is in the game of Sudoku and discussed different aspects of this game. I have seen other people playing it, but did not know the rules or any of the mathematics behind it.

In this game, a 9x9 playing space is provided. An example given was:

		6	2			5	8	
4		2	5					7
				7	8	6		3
5		1		6	7			8
	3						6	
6			8	2		9		1
7		4	3	9				
9					5	2		6
	5	3			1	4		

To “solve” the puzzle, one could just enter numbers in a brute-force kind of way to see if they could get a working configuration. However, sitting in a room full of mathematicians, taking a more analytical approach seemed to be the dominant strategy. Treating this as a constraint-satisfaction problem, you can identify that certain cells must contain specific values. This leads to the conclusion that there is exactly one solution to a “well-formed” Sudoku.

This got me thinking about well-formed Sudoku, and how they are generated in the first place. It seems unlikely that the seeds are randomly assigned, you run the risk of violating set-up rules. A bigger problem is that the seeds may not constrain the possibilities enough to make a unique solution. Another naïve approach might be to take a completed grid and start taking away numbers, but I suspect that you might have a similar issue in terms of necessary constraints.

One that I want to think about is: In forming a viable Sudoku, is it the number of seeds or the placement of seeds that is more critical? I suspect the latter. Also,

- What is the maximum number of seed numbers that can be provided and still result in an ambiguous (unsolvable) puzzle?
- What is the minimum number of seed numbers that can be provided to generate a (uniquely) solvable puzzle?

We were provided two puzzles – one was rated “Easy” the other “Difficult”.

- What goes into the rating system?
- Does a difficult puzzle necessarily have fewer seed numbers?
- Is the rating of the complexity somehow determined by the deductive skills required?

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ACSI 301 Information Sheet

Name:

Email:

Cell phone:

Intended Major:

Hometown:

List any other math/business/economics courses you have taken.

Do you plan to take Exam P or Exam FM while at Roanoke? If so, when?

What are some of the co-curricular or other campus activities you would like to participate in this year?