

**ACTS 4308****SYLLABUS****FALL 2018****Actuarial Financial Mathematics**

**BRIEF DESCRIPTION:** The purpose of this 3 semester credit hour course is to provide an understanding of the fundamental concepts of financial mathematics, and how those concepts are applied in calculating present and accumulated values for various streams of cash flows as a basis for future use in: reserving, valuation, pricing, asset/liability management, investment income, capital budgeting, and valuing contingent cash flows. The topics discussed include loans, bonds and annuities, as well as determinants of interest rates and interest rates swaps. This class covers topics of CAS Exam 2/SOA Exam FM. Prerequisites: ([MATH 2451](#) and [FIN 3320](#)) or instructor consent required.

The class meets on T/TH 11:30 am – 12:45 pm in room [CB3 1.306](#).

**REQUIED BACKGROUND:** This course assumes a basic knowledge of calculus and an introductory knowledge of finance.

**INSTRUCTOR:** Natalia A. Humphreys

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Webpage: <http://www.utdallas.edu/~natalia.humphreys/>

Office Hours: T/TH 1:00 pm – 2:00 pm, or by appointment.

**LEARNING OUTCOMES:**

At the end of the course students will have knowledge in the following areas:

- A. Time Value of Money (10-15%)
  1. The student will be able to define and recognize the definitions of the following terms: interest rate (rate of interest), simple interest, compound interest, accumulation function, future value, current value, present value, net present value, discount factor, discount rate (rate of discount), convertible monthly, nominal rate, effective rate, inflation and real rate of interest, force of interest, equation of value.
  2. The student will be able to:

- a. Given any three of interest rate, period of time, present value, current value, and future value, calculate the remaining item using simple or compound interest. Solve time value of money equations involving variable force of interest.
- b. Given any one of the effective interest rate, the nominal interest rate convertible  $m$ -thly, the effective discount rate, the nominal discount rate convertible  $m$ -thly, or the force of interest, calculate any of the other items.
- c. Write the equation of value given a set of cash flows and an interest rate.

B. Annuities/cash flows with payments that are not contingent (15-20%)

1. The student will be able to define and recognize the definitions of the following terms:  
  
annuity-immediate, annuity due, perpetuity, payable  $m$ -thly or payable continuously, level payment annuity, arithmetic increasing/decreasing annuity, geometric increasing/decreasing annuity, term of annuity.
2. For each of the following types of annuity/cash flows, given sufficient information of immediate or due, present value, future value, current value, interest rate, payment amount, and term of annuity, the student will be able to calculate any remaining item.
  - a. Level annuity, finite term
  - b. Level perpetuity
  - c. Non-level annuities/cash flows
    - i) Arithmetic progression, finite term
    - ii) Arithmetic progression, perpetuity
    - iii) Geometric progression, finite term
    - iv) Geometric progression, perpetuity
    - v) Other non-level annuities/cash flows

C. Loans (15-20%)

1. The student will be able to define and recognize the definitions of the following terms: principal, interest, term of loan, outstanding balance,

final payment (drop payment, balloon payment), amortization, sinking fund.

2. The student will be able to:
  - a. Given any four of term of loan, interest rate, payment amount, payment period, principal, calculate the remaining item.
  - b. Calculate the outstanding balance at any point in time.
  - c. Calculate the amount of interest and principal repayment in a given payment.
  - d. Given the quantities, except one, in a sinking fund arrangement calculate the missing quantity.
  - e. Perform similar calculations to a-d when refinancing is involved.

#### D. Bonds (15-20%)

1. The student will be able to define and recognize the definitions of the following terms: price, book value, amortization of premium, accumulation of discount, redemption value, par value/face value, yield rate, coupon, coupon rate, term of bond, callable/non-callable.
2. Given sufficient partial information about the items listed below, the student will be able to calculate the any of the remaining items.
  - a. Price, book value, amortization of premium, accumulation of discount
  - b. Redemption value, face value
  - c. Yield rate
  - d. Coupon, Coupon rate
  - e. Term of bond, point in time that a bond has a given book value, amortization of premium, or accumulation of discount

#### E. General Cash Flows and Portfolios (10-15%)

1. The student will be able to define and recognize the definitions of the following terms: yield rate/rate of return, dollar-weighted rate of return, time-weighted rate of return, current value, duration (Macaulay and modified), convexity (Macaulay and modified), portfolio, spot rate, forward rate, yield curve, stock price, stock dividend.

2. The student will be able to:
  - f. Calculate the dollar-weighted and time-weighted rate of return.
  - g. Calculate the duration and convexity of a set of cash flows.
  - h. Calculate either Macaulay or modified duration given the other.
  - i. Use duration to approximate the change in present value due to a change in interest rate.
    - i. Using 1<sup>st</sup>-order linear approximation based on modified duration.
    - ii. Using 1<sup>st</sup>-order approximation based on Macaulay duration.
  - j. Calculate the price of a stock using the dividend discount model.

F. Immunization (10-15%)

1. The student will be able to define and recognize the definitions of the following terms: cash flow matching, immunization (including full immunization), Redington immunization.
2. The student will be able to:
  - k. Construct an investment portfolio to fully immunize a set of liability cash flows.
  - l. Construct an investment portfolio to match present value and duration of a set of liability cash flows.
  - m. Construct an investment portfolio to exactly match a set of liability cash flows.

G. Interest Rate Swaps (0-10%)

1. The student will be able to define and recognize the definitions of the following terms: swap rate, swap term or swap tenor, notional amount, market value of a swap, settlement dates, settlement period, counterparties, deferred swap, amortizing swap, accreting swap, interest rate swap net payments.
2. The student will be able to:
  - n. Calculate the swap rate in an interest rate swap, deferred or otherwise, and with either constant or varying notional amount.
  - o. Calculate the market value of an interest rate swap, deferred or otherwise, and with either constant or varying notional amount.

H. Determinants of Interest Rates (0-10%)

1. The student will be able to define and recognize the components of interest rates including: real risk-free rate, inflation rate, default risk premium, liquidity premium, and maturity risk premium.
2. The student will be able to identify the real interest and the nominal interest rate in the context of loans with and without inflation protection and calculate the effect of changes in inflation on loans with inflation protection.
3. The student will be able to explain how the components of interest rates apply in various contexts, such as commercial loans, mortgages, credit cards, bonds, government securities.
4. The student will be able to explain the roles of the Federal Reserve and the FOMC in carrying out fiscal policy and monetary policy and the tools used by the Federal Reserve and the FOMC including targeting the Federal Funds rate, setting reserve requirements, and setting the discount rate.
5. The student will be able to explain the theories of why interest rates differ by term, including liquidity preference (opportunity cost), expectations, preferred habitat, and market segmentation.
6. The student will be able to explain how interest rates differ from one country to another (e.g., U.S. vs. Canada).

**TEXTBOOK** (required): Dinius J., Hassett M., Ratliff M., SOA Exam FM Study Manual, recent edition.

**ADDITIONAL TEXTS** (not required, but useful – check the library for these resources):

1. Broverman, S.A., *Mathematics of Investment and Credit* (recent edition), ACTEX Publications
2. Daniel, J.W., and Vaaler, L.J.F., *Mathematical Interest Theory* (recent edition), The Mathematical Association of America
3. Kellison, S.G., *The Theory of Interest* (recent edition), Irwin/McGraw-Hill
4. Francis, J. and Ruckman, C., *Interest Theory - Financial Mathematics and Deterministic Valuation*; (recent edition), ActuarialBrew
5. Chan, Wai-Sum, and Tse, Yiu-Kuen, *Financial Mathematics for Actuaries*, (recent edition), McGraw-Hill Education (Asia)

**CALCULATORS** (required): Due to a large number of problems relying on specific financial keys, an SOA approved exam calculator is required: **the battery or solar-powered Texas Instruments BA-35 model calculator, the BA II Plus, the BA II Plus Professional, the TI-30Xa or TI-30X II (IIS solar or IIB battery), or TI-30X MultiView (XS Solar or XB Battery).**

For additional information please see:

<https://www.soa.org/Education/Exam-Req/Exam-Day-Info/edu-id-calculators.aspx>

**MATERIAL COVERED:**

<b>Topic Number</b>	<b>Topic Name</b>
1	Interest Rates and the Time Value of Money
2	Annuities
3	Loan repayment
4	Bonds
5	Yield Rate of an Investment
6	The Term Structure of Interest Rates
7	Asset Liability Management
8	Determinants of Interest Rates
9	Interest Rate Swaps

**Exam FM information:**

<https://www.soa.org/education/exam-req/edu-exam-fm-detail.aspx>

98-100	A+
94-97	A
90-93	A-
85-89	B+
80-84	B
75-79	B-
70-74	C+
65-69	C
60-64	C-
55-59	D+
50-54	D
45-49	D-
0-44	F

**GRADING:** Your grade will be based on weekly homework, two midterms and a final exam and will be assigned based on the following grade scale and weights:

**DATES:** Homework – weekly;

Midterm I – Thursday, September 27, 2018, 11:30 am - 12:45 pm, [CB3 1.306](#);

Midterm II – Thursday, November 8, 2018, 11:30 am - 12:45 pm, [CB3 1.306](#);

Final – Tuesday, December 11, 2018, 11:00 am - 1:45 pm, [CB3 1.306](#).

**WEIGHTS:** Attendance and Participation: 5%, Homework: 15%, Midterms: 25% each, Final: 30%

Assignments should be submitted by due date specified in class at the beginning of the class period. Only the grades for the assignments collected **in class** will be recorded. There will be **no make-up exams** unless accompanied by a note from a doctor, religious or otherwise documented official reason pertained to the University business. Undocumented cases will not be honored.

**CALCULATORS:** In order to simulate an actuarial exam conditions, an SOA approved exam calculator is recommended: **the battery or solar-powered Texas Instruments BA-35 model calculator, the BA II Plus, the BA II Plus Professional**, the TI-30Xa or TI-30X II\* (IIS solar or IIB battery), or TI-30X MultiView (XS Solar or XB Battery).

For additional information please see:

<http://www.soa.org/education/exam-req/exam-day-info/edu-calculators.aspx>

**USE OF CELL PHONES or OTHER ELECTRONIC DEVICES:** Unless there is a true emergency, any use of cell phones or other electronic devices unrelated to the course during the class period is **strictly prohibited**. Violators will be asked to stop using the device immediately. Repeated violations will be reflected in the student’s grade.

*Please note: the instructor reserves the right to make changes to this syllabus*

## **GENERAL RULES:**

### **Field Trip Policies, Off-Campus Instruction and Course Activities**

Off-campus, out-of-state, and foreign instruction and activities are subject to state law and University policies and procedures regarding travel and risk-related activities.

Information regarding these rules and regulations may be found at [http://www.utdallas.edu/BusinessAffairs/Travel\\_Risk\\_Activities.htm](http://www.utdallas.edu/BusinessAffairs/Travel_Risk_Activities.htm). Additional information is available from the office of the school dean.

### **Student Conduct and Discipline**

The University of Texas System and The University of Texas at Dallas have rules and regulations for the orderly and efficient conduct of their business. It is the responsibility of each student and each student organization to be knowledgeable about the rules and regulations which govern student conduct and activities. General information on student conduct and discipline is contained in the UT Dallas printed publication, *A to Z Guide*, which is available to all registered students each academic year.

The University of Texas at Dallas administers student discipline within the procedures of recognized and established due process. Procedures are defined and described in the *Rules and Regulations, Series 50000*, Board of Regents, The University of Texas System, and in *Title V, Rules on Student Services and Activities* of the university's *Handbook of Operating Procedures*. Copies of these rules and regulations are available to students in the Office of the Dean of Students, where staff members are available to assist students in interpreting the rules and regulations (SU 1.602, 972/883-6391) and online at <http://www.utdallas.edu/judicialaffairs/UTDJudicialAffairs-HOPV.html>.

A student at the university neither loses the rights nor escapes the responsibilities of citizenship. He or she is expected to obey federal, state, and local laws as well as the Regents' Rules, university regulations, and administrative rules. Students are subject to discipline for violating the standards of conduct whether such conduct takes place on or off campus, or whether civil or criminal penalties are also imposed for such conduct.

[Added July 2010] Students are expected to be attentive during class and to participate actively in group activities. Students are expected to listen respectfully to faculty and to other students who are speaking. Racism, sexism, homophobia, classism, ageism, and other forms of bigotry are inappropriate to express in class. Classes may discuss issues that require sensitivity and maturity. Disruptive students will be asked to leave and may be subject to disciplinary action.

## Academic Integrity

The faculty expects from its students a high level of responsibility and academic honesty. Because the value of an academic degree depends upon the absolute integrity of the work done by the student for that degree, it is imperative that a student demonstrate a high standard of individual honor in his or her scholastic work.

*Scholastic Dishonesty:* Any student who commits an act of scholastic dishonesty is subject to discipline. Scholastic dishonesty includes but is not limited to cheating, plagiarism, collusion, submitting for credit any work or materials that are attributable in whole or in part to another person, taking an examination for another person, or any act designed to give unfair advantage to a student or the attempt to commit such acts.

Plagiarism, especially from the web, from portions of papers for other classes, and from any other source, is unacceptable and will be dealt with under the university's policy on plagiarism (see general catalog for details). This course will use the resources of *turnitin.com*, which searches the web for possible plagiarism and is over 90% effective.

## Copyright Notice

The copyright law of the United States (*Title 17, United States Code*) governs the making of photocopies or other reproductions of copyrighted materials, including music and software. Copying, displaying, reproducing, or distributing copyrighted works may infringe upon the copyright owner's rights and such infringement is subject to appropriate disciplinary action as well as criminal penalties provided by federal law. Usage of such material is only appropriate when that usage constitutes "fair use" under the Copyright Act. As a UT Dallas student, you are required to follow the institution's copyright policy ([Policy Memorandum 84-I.3-46](#)). For more information about the fair use exemption, see <http://copyright.lib.utexas.edu/copypol2.html>.

## Email Use

The University of Texas at Dallas recognizes the value and efficiency of communication between faculty/staff and students through electronic mail. At the same time, email raises some issues concerning security and the identity of each individual in an email exchange. The university encourages all official student email correspondence be sent only to a student's UT Dallas email address and that faculty and staff consider email from students official only if it originates from a UT Dallas student account. This allows the university to maintain a high degree of confidence in the identity of all individuals corresponding and the security of the transmitted information. UT Dallas furnishes each student with a free email account that is to be used in all communication with university personnel. The Department of Information

Resources at UT Dallas provides a method for students to have their UT Dallas mail forwarded to other accounts.

### **Class Attendance**

Regular and punctual class attendance is expected. Students who fail to attend class regularly are inviting scholastic difficulty. Absences may lower a student's grade where class attendance and class participation are deemed essential by the instructor. In some courses, instructors may have special attendance requirements; these should be made known to students during the first week of classes.

### **Withdrawal from Class**

The administration of this institution has set deadlines for withdrawal from any college-level courses. These dates and times are published in that semester's course inventory and in the academic calendar. Administration procedures must be followed. It is the student's responsibility to handle withdrawal requirements from any class. In other words, a professor or other instructor cannot drop or withdraw any student. You must do the proper paperwork to ensure that you will not receive a final grade of "F" in a course if you choose not to attend the class once you are enrolled.

### **Student Grievance Procedures**

Procedures for student grievances are found in *Title V, Rules on Student Services and Activities*, of the university's *Handbook of Operating Procedures*.

In attempting to resolve any student grievance regarding grades, evaluations, or other fulfillments of academic responsibility, it is the obligation of the student first to make a serious effort to resolve the matter with the instructor, supervisor, administrator, or committee with whom the grievance originates (hereafter called "the respondent"). Individual faculty members retain primary responsibility for assigning grades and evaluations. If the matter cannot be resolved at that level, the grievance must be submitted in writing to the respondent with a copy of the respondent's School Dean. If the matter is not resolved by the written response provided by the respondent, the student may submit a written appeal to the School Dean. If the grievance is not resolved by the School Dean's decision, the student may make a written appeal to the Dean of Graduate or Undergraduate Education, and the dean will appoint and convene an Academic Appeals Panel. The decision of the Academic Appeals Panel is final. The results of the academic appeals process will be distributed to all involved parties.

Copies of these rules and regulations are available to students in the Office of the Dean of Students, where staff members are available to assist students in interpreting the rules and regulations.

### **Incomplete Grade Policy**

As per university policy, incomplete grades will be granted only for work unavoidably missed at the semester's end and only if 70% of the course work has been completed. An incomplete grade must be resolved within eight (8) weeks from the first day of the subsequent long semester. If the required work to complete the course and to remove the incomplete grade is not submitted by the specified deadline, the incomplete grade is changed automatically to a grade of F.

### **Office of Student AccessAbility (OSA)**

UT Dallas is committed to providing equal educational opportunities for students with documented disabilities to all University courses and programs. Any student with a documented physical, psychological, or learning disability, which affects his/her academic performance, is eligible for services. If you need classroom accommodations, please make an appointment with the Office of Student AccessAbility at: SSB 3.200 (3rd Floor in SSB), 972-883-2098. Office hours are Monday – Thursday, 8:30 a.m. - 6:00 p.m., Friday 8:00 a.m. – 5:00 p.m. Evening appointments are available by request. <http://www.utdallas.edu/studentaccess/>

OSA provides registered students with an accommodation letter to present to faculty members. The letter verifies that the student is qualified to receive certain accommodations. The accommodation letter should be presented to instructors of each course at the beginning of the semester. The approved accommodations should be discussed at that time. It is the student's responsibility to notify his/her professor of their needs.

The University of Texas at Dallas is proud to be an educational institution that welcomes and supports a diverse student body.

### **Religious Holy Days**

The University of Texas at Dallas will excuse a student from class or other required activities for the travel to and observance of a religious holy day for a religion whose places of worship are exempt from property tax under Section 11.20, Tax Code, *Texas Code Annotated*.

The student is encouraged to notify the instructor or activity sponsor as soon as possible regarding the absence, preferably in advance of the assignment. The student, so excused, will be allowed to take the exam or complete the assignment within a reasonable time after the absence: a period equal to the length of the absence, up to a maximum of one week. A student who notifies the instructor and completes any missed exam or assignment may not be penalized for the absence. A student who fails to complete the exam or assignment within the prescribed period may receive a failing grade for that exam or assignment.

If a student or an instructor disagrees about the nature of the absence [i.e., for the purpose of observing a religious holy day] or if there is similar disagreement about whether the student has been given a reasonable time to complete any missed assignments or examinations, either the student or the instructor may request a ruling from the chief executive officer of the institution, or his or her designee. The chief executive officer or designee must take into account the legislative intent of *TEC 51.911(b)*, and the student and instructor will abide by the decision of the chief executive officer or designee.

### **Avoiding Plagiarism**

[Adapted from Duke University's guidelines for writers; added July 2010]

*Take time to make careful choices among--and learn to use--the research tools* available to you. You will probably find that your favorite web search engine is not adequate by itself for college-level research. Consult with your professor or a librarian. You may need to use specialized research tools, some of which may require learning new searching techniques.

*Expect to make trips to the library.* While you can access many of the library's resources from your home computer, you may find that you need to make several trips to use materials or research tools that are not accessible remotely. Of course, you will be seeking the best information, not settling for sources simply because they happen to be available online.

*Allow time for gathering materials* that are not available at UT Dallas. The InterLibrary Loan Office can borrow articles and books from other libraries, but this process takes additional time.

*Allow time for reading*, rereading, absorbing information, taking notes, synthesizing, and revising your research strategy or conducting additional research as new questions arise.

*Sloppy note-taking increases the risk that you will unintentionally plagiarize.* Unless you have taken note carefully, it may be hard to tell whether you copied certain passages exactly, paraphrased them, or wrote them yourself. This is especially problematic when using electronic source materials, since they can so easily be copied and pasted into your own document.

*Identify words that you copy directly* from a source by placing quotation marks around them, typing them in a different color, or highlighting them. (Do this immediately as you are making your notes. Don't expect to remember days or weeks later what phrases you copied directly.) Make sure to indicate the exact beginning and end of the quoted passage. Copy the wording, punctuation and spelling exactly as it appears in the original.

*Jot down the page number and author or title* of the source each time you make a note, even if

you are not quoting directly but are only paraphrasing.

*Keep a working bibliography* of your sources so that you can go back to them easily when it's time to double-check the accuracy of your notes. If you do this faithfully during the note-taking phase, you will have no trouble completing the "works cited" section of your paper later on.

*Keep a research log.* As you search databases and consult reference books, keep track of what search terms and databases you used and the call numbers and URLs of information sources. This will help if you need to refine your research strategy, locate a source a second time, or show your professor what works you consulted in the process of completing the project.

*You must cite direct quotes.*

*You must cite paraphrases.* Paraphrasing is rewriting a passage or block of text in your own words. If you paraphrase, you must still cite the original source of the idea.

*You must cite ideas* given to you in a conversation, in correspondence, or over email.

*You must cite sayings or quotations that are not familiar, or facts that are not "common knowledge."* However, it is not necessary to cite a source if you are repeating a well known quote or familiar proverb. Common knowledge is something that is widely known. For example, it is widely known that Bill Clinton served two terms as president; it would not be necessary to cite a source for this fact.

*These types of sources should be cited as well.* *Printed sources:* Books, parts of books, magazine or journal articles, newspaper articles, letters, diaries, public or private documents; *Electronic sources:* Web pages, articles from e-journals, newsgroup postings, graphics, email messages, software, databases; *Images:* Works of art, illustrations, cartoons, tables, charts, graphs; *Recorded or spoken material:* Course lectures, films, videos, TV or radio broadcasts, interviews, public speeches, conversations.

### **Resources to Help You Succeed**

The GEMS Center (located within the Conference Center) provides a wide array of free academic support and enhancement for UT Dallas undergraduate students. Offerings include, but are not limited to, a Math Lab and Writing Center, Peer Tutoring (with a focus on science, technology, engineering and math courses), test review sessions, and academic success coaching. The current menu of services, schedules, and contact information is posted on the GEMS website:

<http://www.utdallas.edu/ossa/gems/>. [Added July 2010]