University of Catania – Department of Economics and Business

Degree in Business Economics (Economia Aziendale)
Academic year 2015/16

Financial Mathematics (2nd Year, 2nd semester, 6 CFU; 1 CFU = 25 hours)

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Student receiving timetable: Monday and Tuesday, 5-7 pm

General Objectives of teaching in terms of expected results of learning

Knowledge and understanding. The course provides the theoretical principles underlying the time value of money under certainty (rates and their structure, rules of capitalization, depreciation, capital formation, evaluation of loans, bonds, investment analysis). It also provides tools to manage interest rate risk (duration and convexity). Alongside the theoretical knowledge, properly formalized, the course is intended to transfer professional skills. Indeed, the topics covered are explained paying attention to the operational point of view, in order to provide the knowledge needed to apply the methods and the techniques studied to real world problems (know how to evaluate, compare, making decisions). To achieve these goals, appropriate equipment and teaching supports are used, such as multimedia presentation, database accessing, spreadsheets. The whole training of the discipline also aims at developing the inductive-deductive logical process of the students' learning. The final examination (structured as written and oral tests) is not the ultimate goal. During the whole course there is a continuous checking of the comprehension and the real acquisition of the taught knowledge. There is an active participation of the students to the teaching process.

Applying knowledge and understanding. Particular attention is paid to stimulate the professional skills of the potential graduates. To this end, lecturers use a didactic methodology oriented towards the acquisition of operational capacities (know-how) concerning the analytical tools and the theoretical concepts provided during the course. Real world cases are often submitted to the students. The final examination must verify the effective acquisition of these skills.

Making judgments. The development of a critical understanding of the topics provided by the course is a major educational objective. The learning skillfulness must be accompanied by a thorough capacity of evaluating, assessing and solving a problem using the most appropriate methods and techniques, whereas the student is asked to check the proper limits. During the whole course, the interaction with all the students is fundamental, and is pursued in a constructive way with the aim of stimulating the ultimate understanding of the information needed to set up, analyze and solve the fixed problems, avoiding a sterile mnemonic preparation. The students are trained via the most appropriate economic and financial sources (academic publications, databases, Internet sites, etc.). The students will also learn to analyze and evaluate the reliability and meaningfulness of such information and data, to use them appropriately by dealing with real world problems.

Communication skills. It is not enough to be able to apply correct methods and techniques to deal with the problem at hand. It is also necessary to justify them, revealing the underlying assumptions on which the analysis is based. To this end, besides the appropriate theoretical knowledge its practical implementation, it is important to use computational tools and multimedia technology. The course is then designed in order to develop these skills, by ensuring the active participation of the students. They are asked to illustrate their understanding via written notes, and to prepare presentations individually and in groups. These are discussed in the classroom. The final exam has the additional aim of verifying the communication skill developed by the students during the course.

Learning skills. The students are asked to improve their method of study, in view of a more effective learning of the arguments in the program. The checking of the actual acquisition of theoretical and operational knowledge, necessary for entering the job's world, takes place during the entire course. Lecturers possibly review their method of teaching. The learning process is then constantly monitored and improved, avoiding a negligible approach.

Pre-requisites	The arithmetic operations and their properties; primes, factorization, the greatest common divisor and least common multiple; fractions and operations on fractions; powers, roots and logarithms; monomials, polynomials and decomposition of polynomials; first order and second order equations. It is also useful the knowledge of the fundamentals of differential calculus, from the program of General Mathematics in the same course.
Teaching organization/ methods	The course is based on about forty hours of lectures during which the main topics are presented. Possible applications to economics and business management are emphasized. The topics are first presented intuitively and then mathematically formalized. Exercises play a vital role in order to master the fundamentals.
Attendance	Highly recommended.
Reference texts	**1.** F. Cacciafesta, *Lezioni di matematica finanziaria classica e moderna*, Giappichelli,Torino, 2001 **2.** R. L. D'Ecclesia, L. Gardini, *Appunti di Matematica Finanziaria I*, VII edizione, Giappichelli, Torino, 2013 **3.** F. Moriconi, *Matematica finanziaria*, Il Mulino, Bologna, 1994 **4.** B. Matarazzo, *Sulla scelta degli investimenti privati*, Catania **5.** E. Volpe di Prignano, *Lezioni di matematica finanziaria avanzata*, CISU, 2009
Evaluation	**Progress test**: To ensure the proper quality and the effectiveness of the method of studying, the second year students can take advantage of an ongoing evaluation based upon a written examination concerning the first module of the program. Until the end of the academic year, students who passed the progress test are admitted to the final oral examination, after passing a class test in which they will be required to solve only those exercises concerning the second module of the program. Starting from the first session of the subsequent academic year, this benefit no longer applies. **Final term evaluation**: The final examination comprises a class test and an oral exam. The class test aims at verifying the student's understanding of the theoretical concepts and their practical application. The class test is based on a fixed number of exercises. Passing the class test is mandatory: otherwise the students cannot access the oral exam. This last aims at verifying the proper knowledge of all the subjects provided by the course modules. Both the aforementioned class test and oral exams count towards the final mark. Note that a minimum level of knowledge of the topics treated in the course is necessary to pass the whole exam. **Evaluation dates**: http://www.economia.unict.it/Didattica/Diario-esami
Learning Material	**INDERIRE L'URL DI STUDIUM**

Course syllabus

MODULE # 1 (3 CFU)
Financial conventions, annuities, amortizations, founding capital

Learning goals: Providing both the theory and practice of elementary financial calculus under certainty. As a byproduct, this helps to develop professional skills.

Topic description: The financial function and its properties. Financial convention: simple, commercial and compound; mixed cases; rational vs commercial discount. Equivalent interest rates, nominal interest rates, instantaneous convention. Annuities and their classification: general discrete, periodic, constant, fractional, continuous, perpetual. Annuities in compound convention: periodic arithmetic and geometric progression payment; perpetuities. Inverse problems. Unshared loan and amortization: general properties. Compound convention in amortization: Single settlement repayment; multiple settlement repayments: general weak amortization installments; several interest repayments and single repayment of the principal (general and periodic); several interest repayments and single repayment of the principal with collateral funding of the principal: general case. American amortization. Italian amortization. French amortization. German amortization. Cession's value of rights concerning a loan's amortization. Capital accumulation: discrete case.

MODULE # 2 (3 CFU)
Valuation of financial and real investments

Learning goals: Providing the theory and the main techniques for evaluating both financial and real investments. Explaining the concept of interest rate risk and the corresponding techniques of immunization.
Topic description: Loan evaluation and general investment evaluation. Bare ownership and usufruct. Investments in real markets under certainty. Some useful criteria of investment evaluation: Net Present Value (NPV); Internal Rate of Return (IRR); Payback period. Comparison among criteria. Shared loan amortization: basic concepts. Constant amortization installments, constant reimbursement price. Effective rate for the issuer; cession's value of the credit; effective rate for the holder. Cession's value of a bond. Bond's market: prices vs rates/yields. Zero coupon bonds. Fixed coupon bonds. The structure of the market. Forward rates and spot rates. Immunization: basic principles. Interest rate risk. Theorems of immunization: parallel and nonparallel shifts. Time indexes: arithmetic mean maturity; duration and modified duration. Convexity.

Topics	Required Texts
*1. Financial operations; interest rate and discount rate; capitalization and actualization.	**Cacciafesta: chap 1** **D'Ecclesia, Gardini: chap 1**
*2. The financial function and its properties. Equivalent values. Financial convention: simple, compound.	**Cacciafesta: chap 2** **D'Ecclesia, Gardini: chap 1**
*3. Commercial convention vs rational discount. Comparison among the three conventions; mixed convention.	**Cacciafesta: chap 2** **D'Ecclesia, Gardini: chap 1**
*4. Different definitions of interest rates: nominal, effective, average and instantaneous.	**Cacciafesta: chap 2** **D'Ecclesia, Gardini: chap 1**
*5. Decomposability of the financial function; discrete and continuously varying interest (discount) rates	**Cacciafesta: chap 3** **D'Ecclesia, Gardini: chap 1**
*6. Annuities under certainty: basic principles. Different kinds: discrete, temporary, constant capital repayment.	**Cacciafesta: chap 4** **D'Ecclesia, Gardini: chap 2**
*7. Other kinds of annuities: perpetual, delayed, discrete and fractional; constant and nonconstant installments. Direct and inverse problems.	**Cacciafesta: chap 4** **D'Ecclesia, Gardini: chap 2**
*8. Unshared loan amortization and capital accumulation: basic principles and properties.	**Cacciafesta: chap 5** **D'Ecclesia, Gardini: chap 3**
*9. Unshared loan amortization, special cases: constant installments; several interest repayments and single repayment of the principal (general and periodic case).	**Cacciafesta: chap 5** **D'Ecclesia, Gardini: chap 3**
*10. Settlement repayment and amortization: constant rate, variable rate, pre-amortization, final bonus.	**Cacciafesta: chap 5** **D'Ecclesia, Gardini: chap 3**
*11. Accumulation settlements: constant rate, variable rate; other cases.	**Cacciafesta: chap 4** **D'Ecclesia, Gardini: chap 2**
*12. Loan evaluation: basic principles. Retrospective and	**Cacciafesta: chap 6**

perspective convention.	**D'Ecclesia, Gardini: chap 4**
*13. Bare ownership and usufruct. Evaluation of typical loan classes	**Cacciafesta: chap 6** **D'Ecclesia, Gardini: chap 4**
*14. Investment in real markets under certainty: basic principles and evaluation techniques.	**Cacciafesta: chap 7** **D'Ecclesia, Gardini: chap 4**
*15. Net present value; internal rate of return; payback period.	**Cacciafesta: cap 7** **D'Ecclesia, Gardini: chap 4**
*16. Investment criteria evaluation and decision making. Comparison among different criteria.	**Cacciafesta: chap 7** **D'Ecclesia, Gardini: chap 4**
*17. Fixed income securities. Prices vs rates/yield. Shared loan amortization.	**Cacciafesta: chap 6 and Appendix B** **D'Ecclesia, Gardini: chap 5**
*18. Yield curve (spot rates and forward rates)	**Cacciafesta: chap 6 and Appendix B** **D'Ecclesia, Gardini: chap 5**
*19. Duration and convexity.	**Cacciafesta: Appendix A** **D'Ecclesia, Gardini: chap 4**
*20. Principles of immunization: Fisher-Weil Theorem and Redington's Theorem.	**Cacciafesta: Appendix A** **D'Ecclesia, Gardini: chap 7**

Typical/frequent questions/exercises

- What are the interest, the discount, the future value and the present value?
- What are the interest rate and the discount rate and what is their functional relation?
- What is a financial convention?
- What are the simple, composed and commercial financial conventions?
- Do you know how compare the simple, composed and commercial financial conventions?
- What are two equivalent rates?
- What are the force of interest and the force of discount?
- What is the decomposability?
- What is the necessary and sufficient condition for decomposability?
- What are the present value and the future value of an annuity of n instalments?
- What are the present value and the future value of an annuity of n instalments in arithmetic progression?
- What are the present value and the future value of an annuity of n instalments in geometric progression?
- What are the differences between the French amortization, the Italian amortization, the American amortization and the German amortization?
- What are the bare ownership and the usufruct?
- What is the Makeham's formula? How it is obtained and how it is applied?
- What are the criteria of net present value and internal

rate of return?

- What are spot rates and forward rates and which relation there is between them?
- What are duration and convexity?
- Can you enunciate the Fisher-Weil theorem?
- Can you enunciate the Redington Theorem?