Preface

I.1. Who will gain, and what, from this book

This book has been written for undergraduate and graduate students in a variety of disciplines, from financial mathematics to investments to computer science. Teachers, professors, and industry specialists will also find this book an invaluable educational and practical resource of knowledge for these widely used financial instruments - mortgages and annuities. The style of the material presentation, and partly the material itself, has been successfully tested in the first edition of the author's voluminous work "Science of Inexact Mathematics" (Shestopaloff, 2009). This work received good response from specialists working in the financial industry, academics and reviewers. The author adjusted the level of material presentation to the requirements of programs and courses for undergraduate students, and accordingly for teaching assistants and instructors delivering such courses. The book also appeals to educational interests of the most numerous category of industry professionals needed practical knowledge and understanding of the subject for everyday operations routinely done in the investment analytical departments. Software system designers, implementing such financial systems, need both knowledge of underlying mathematics and computational algorithms. The book addresses the needs of software developers as well. The author has first

hand experience in designing and implementing financial systems, and especially their computational modules, which he shares with readers in concise academic form.

Students and teachers reviewing the first book especially valued the idea to support the book material by exhaustive numerical examples, tabular and graphical illustrations. This presentation approach is preserved and enhanced. The features which attracted this category of readers the most were logical consistency of the presentation, transparency of mathematical derivations and transformations, abundant numerical examples presented in different forms, and comprehensive coverage. Many readers discovered important details and concepts, of which they were not aware for years, even if they taught the subjects themselves. Their vision and knowledge of the subject, according to their words, "became much more coherent and transparent". This book continues the same approach and sets this goal as the main criterion in writing this book.

The first book received a warm welcome from industry specialists, although the advanced level of material apparently restricted the audience. Doing presentations for investment analysts, the author discovered that some advanced concepts required additional efforts for understanding, although in some instances these topics should be in the category of optional methods and concepts. So, some filtering was done in this regard. Required by logic of presentation, advanced concepts have been adjusted to the wider audience; some optional concepts were left outside the scope of this book, provided their absence did not

jeopardize the consistency and comprehensiveness of material.

Unlike most of books on this subject of mortgages and annuities, the book extends the subject to computational algorithms for these financial instruments, analyses their computational efficiency and software implementation issues. Although introduction of this topic into the book relates mostly to software developers and system designers, we found that financial analysts are often interested in computational specifics. During consultation and training seminars for the specialists working in the industry, we discovered the following. These people are almost without exception the end users of software systems designed for investment analysis. The questions they asked during training sessions often indicate their practical interest to underlying computational algorithms and their implementation specific. Sometimes the questions reveal misconceptions affecting the interpretation of their analytical studies. In most situations, a short explanation was sufficient to fix these knowledge glitches. We think that this information could be also helpful for undergraduate students to understand the subject better. Of course, some teachers may consider the computational and software implementation part as an optional material whose absence in the program will not jeopardize the quality of their courses based on this book.

On the other hand, through this material related to practical computation students may narrow the usual gap between academic knowledge and its practical application. The author himself had to step over the same

breach, which separates seemingly pure academic knowledge we acquire through years of study, and the loveliness and exuberance of real business. In fact, this step is neither as big, or as wide as we often think; and with concentrated efforts, desire and stimulus, academic knowledge can quickly become an invaluable and powerful practical instrument, which will help young people quicker and smoothly to be incorporated into the real business environment.

I.4. Organization of the book

In Chapter 1, the introduction starts from scratch. The material requires no prior knowledge of the subject. On the mathematical side, the higher school calculus is the only prerequisite for this chapter and the whole course. We first introduce basic definitions, such as those of interest rate. Then, we introduce the mathematical apparatus required for analytical studies of investments from the ground up.

In Chapter 2, we use the simplified form of equation known as IRR (internal rate of return) equation to derive mathematical formulas required to calculate different parameters for annuities. We present many numerical examples, both in graphical and tabular form. Given our experience, this is an efficient approach that will allow the reader to deeply understand the subject. Examples, in our view, like a solid and convenient ladder allowing to confidently move to another knowledge level, while introduction of only abstract theoretical concepts is

similar to unsafe jumping on a vertical wall from one ledge to another. This is one of the reasons why some courses may have 60-70 % of the drop rate, when teaching material moves to another level without assuring that the previous was leant properly. Through the combination of numerical examples and gradually introduced theory students should be able to acquire comfortable understanding of annuities and their mathematical description. After completing this chapter, the reader himself will be able to derive all mathematical formulas for similar financial instruments.

Chapter 3 introduces mortgages. We start from the transformation of IRR equation showing how it incorporates the main specific of conventional mortgages – regular and equal payments. Once the students understand that mortgages just another subset of financial instruments whose quantitative description is based on the same mathematical foundation, IRR equation, it usually makes the rest of material more transparent. We discovered, that students understanding this specific of mortgages are very quick proceeding through the computational part of the course that considers particular mortgage parameters.

On the other hand, there is a substantial number of students which in fact ignored the introductory part as too theoretical, and consequently unnecessary to do the tests. Later, they just memorize mortgage formulas and use them without understanding that actually the subject is simple if one gets the main idea that all these basic formulas have the same origin and can be derived on the

fly. These students can write the tests, but they cannot analyze even slightly different financial instruments. They also lack comprehension how mortgage parameters interrelate to each other. This is why we decided to accentuate this part introducing more numerical examples and exercises. This is was not an absolute remedy, but the learning process, as we found, becomes more successful, and the test results were more uniform. So, the understanding that all mortgage formulas have the same origin, is important, and, probably, it makes sense to consider it in more details including simple assignments.

We found that graphical presentations are helpful in understanding the subject, so we often use this learning tool throughout the book. In particular, mortgage section includes graphs of different interdependencies between mortgage parameters, especially the ones related to interest and principal payments.

Chapter 4 introduces numerical methods for solving IRR equation in order to find interest rate. We explain why the mortgage equation cannot be solved analytically with respect to interest rate, and application of numerical methods is required. We introduce several methods, from the classic Newton-Raphson iteration algorithm to the newest ones such as series reversion method. The advantages and drawback of each method are discussed in detail.

In Chapter 5, the computational performance of earlier discussed algorithms is analyzed in depth. Software implementation issues related to computational

performance, methods' accuracy and robustness receive thorough consideration.

Chapter 6, for the first time, considers implementation of computational methods for finding interest rates in mortgage and annuity calculations specifically for implementation in financial calculators. Although the considered methods can be used in any financial system, the emphasis on the methods" high computational performance makes them appealing to designers of financial calculators.

I.5. Acknowledgements

The author is thankful to his family for the support of the entire project. Numerous valuable advices from his sons and their editing efforts certainly improved the book content and appearance.