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高等院校双语教学适用教材 工商管理

萨里经济管理英文教材

MATHEMATICS FOR ECONOMICS AND BUSINESS

(Seventh Edition)

IAN JACQUES

商务与经济数学

第7版

(英)伊恩·雅克　著

东北财经大学出版社
Dongbei University of Finance & Economics Press

策划　方红星　李季

商务与经济数学

第7版

内容简介

本书是一本商务与经济数学的基础教材，主要面向经济学、工商管理专业的低年级本科生。浅显易懂的语言，鲜活丰富的案例，华丽清新的图表，灵活多样的栏目，都彰显了本书为读者着想的独具匠心，拉近了数学与读者的心理距离，使得学习商务与经济数学的过程更为顺畅有趣。

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出版者的话

当前，在教育部的大力倡导下，财经和管理类专业的双语教学在我国各大高校已经逐步开展起来。一些双语教学开展较早的院校积累了丰富的经验，同时也发现了教学过程中存在的一些问题，尤其对教材提出了更高的要求；一些尚未进入这一领域的院校，也在不断探索适于自身的教学方式和方法以及适用的教材，以期时机成熟时加入双语教学的行列。总之，对各类院校而言，能否找到“适用”的教材已成为双语教学成功与否的关键因素之一。

然而，国外原版教材为国外教学量身定做的一些特点，如普遍篇幅较大、侧重于描述性讲解、辅助材料（如习题、案例、延伸阅读材料等）繁杂，尤其是许多内容针对性太强，与所在国的法律结构和经济、文化背景结合过于紧密等，却显然不适于国内教学采用，并成为制约国内双语教学开展的重要原因。因此，对国外原版教材进行本土化的精简改编，使之变成更加“适用”的双语教材，已然迫在眉睫。

东北财经大学出版社作为国内较早涉足引进版教材的一家专业出版社，秉承自己一贯服务于财经教学的宗旨，总结自身多年的出版经验，同麦格劳—希尔教育出版公司、培生教育出版集团和圣智出版集团等国外著名出版公司通力合作，在国内再次领先推出了会计、工商管理、经济学等专业的“高等院校双语教学适用教材”。尤其是此次双语教材是与东北财经大学萨里国际学院共同推出。东北财经大学萨里国际学院是教育部批准的、与英国萨里大学共建的中外合作办学机构。学院所有课程采取双语和全英文授课方式，因而，东北财经大学出版社与萨里国际学院携手推出此系列双语教材。这套丛书的出版经过了长时间的酝酿和筛选，编选人员本着“品质优先、首推名作”的选题原则，既考虑了目前我国财经教育的现状，也考虑了我国财经高等教育所具有的学科特点和需求指向，在教材的遴选、改编和出版上突出了以下一些特点：

- 优选权威的最新版本。入选改编的教材是在国际上多次再版的经典之作的最新版本，其中有些教材的以前版本已在国内部分高校中进行了试用，获得了一致的好评。
- 改编后的教材在保持英文原版教材特色的基础上，力求内容精要，逻辑严密，适合中国的双语教学。选择的改编人员既熟悉原版教材内容，又具有本书或本门课程双语教学的经验。
- 改编后的教材配有丰富的辅助教学支持资源，教师可在网上免费获取。
- 改编后的教材篇幅合理，符合国内教学的课时要求，价格相对较低。

本套教材是在双语教学教材出版方面的一次新的尝试。我们在选书、改编及出版的过程中得到了国内许多高校的专家、教师的支持和指导，在此深表谢意，也期待广大读者提出宝贵的意见和建议。

尽管我们在改编的过程中已加以注意，但由于各教材的作者所处的政治、经济和文化背景不同，书中的内容仍可能有不妥之处，望读者在阅读中注意比较和甄别。

东北财经大学出版社

THE FOLLOWING ADDITIONAL MATERIAL IS AVAILABLE AS PART OF THE ONLINE RESOURCES (www.pearsoned.co.uk/jacques):

PREFACE

This book is intended primarily for students on economics, business studies and management courses. It assumes very little prerequisite knowledge, so it can be read by students who have not undertaken a mathematics course for some time. The style is informal and the book contains a large number of worked examples. Students are encouraged to tackle problems for themselves as they read through each section. Detailed solutions are provided so that all answers can be checked. Consequently, it should be possible to work through this book on a self-study basis. The material is wide ranging, and varies from elementary topics such as percentages and linear equations to more sophisticated topics such as constrained optimisation of multivariate functions. The book should therefore be suitable for use on both low- and high-level quantitative methods courses.

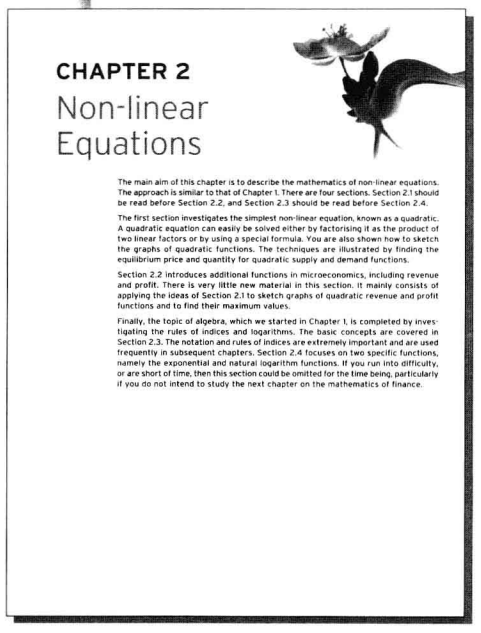
This book was first published in 1991. The prime motivation for writing it then was to try to produce a textbook that students could actually read and understand for themselves. This remains the guiding principle when writing this seventh edition. There are five significant changes based on suggestions made from many anonymous reviewers of previous editions (thank you):

- Answers to all questions are now included in the back of the textbook so that students can check their work easily.
- Fully worked solutions to all practice and core questions are provided in the online resources so that students can learn from their mistakes.
- Enhanced online resources via MyMathLab Global.
- Additional chapters on linear programming and dynamics are now included in the textbook.
- Each chapter concludes with a brief section on formal mathematics designed for those students who wish to take this subject further.
- Examples and exercises are included in the online resources which make use of the computer software packages Excel and Maple.

Ian Jacques

GUIDED TOUR OF THE TEXTBOOK

SETTING THE SCENE



CHAPTER 2

Non-linear Equations

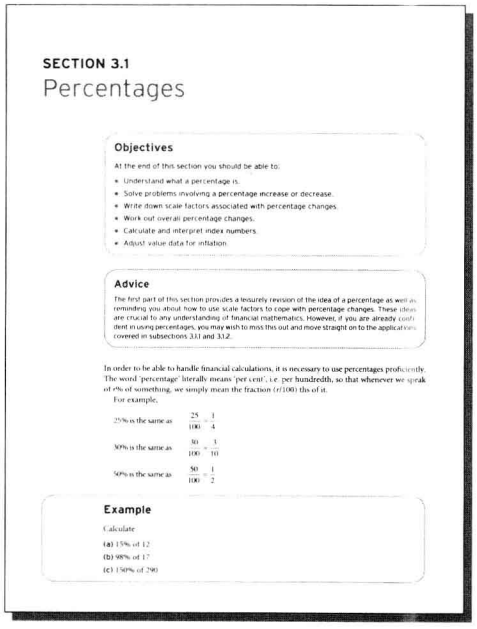
The main aim of this chapter is to describe the mathematics of non-linear equations. The approach is similar to that of Chapter 1. There are four sections. Section 2.1 should be read before Section 2.2, and Section 2.3 should be read before Section 2.4.

The first section investigates the simplest non-linear equation, known as a quadratic. A quadratic equation can easily be solved either by factorising it as the product of two linear factors or by using a special formula. You are also shown how to sketch the graphs of quadratic functions. The techniques are illustrated by finding the equilibrium price and quantity for quadratic supply and demand functions.

Section 2.2 introduces additional functions in microeconomics, including revenue and profit. There is very little new material in this section. It mainly consists of applying the ideas of Section 2.1 to sketch graphs of quadratic revenue and profit functions and to find their maximum values.

Finally, the topic of algebra, which we started in Chapter 1, is completed by investigating the rules of indices and logarithms. The basic concepts are covered in Section 2.3. The notation and rules of indices are extremely important and are used frequently in subsequent chapters. Section 2.4 focuses on two specific functions, namely the exponential and natural logarithm functions. If you run into difficulty, or are short of time, then this section could be omitted for the time being, particularly if you do not intend to study the next chapter on the mathematics of finance.

Chapter **Openers** set the scene, guiding you through the chapter, highlighting key topics and showing you where to find them.



SECTION 3.1

Percentages

Objectives

At the end of this section you should be able to:

- Understand what a percentage is.
- Solve problems involving a percentage increase or decrease.
- Write down scale factors associated with percentage changes.
- Work out overall percentage changes.
- Calculate and interpret index numbers.
- Adjust value data for inflation.

Advice

The first part of this section provides a leisurely revision of the idea of a percentage as well as reminding you about how to use scale factors to cope with percentage changes. These ideas are crucial to any understanding of financial mathematics. However, if you are already confident in using percentages, you may wish to miss this out and move straight on to the applications covered in subsections 3.3.1 and 3.3.2.

In order to be able to handle financial calculations, it is necessary to use percentages proficiently. The word 'percentage' literally means 'per cent', i.e. per hundredth, so that whenever we speak of r% of something, we simply mean the fraction $(r/100)$ this of it.

For example,

25% is the same as $\frac{25}{100} = \frac{1}{4}$

30% is the same as $\frac{30}{100} = \frac{3}{10}$

50% is the same as $\frac{50}{100} = \frac{1}{2}$

Example

Calculate

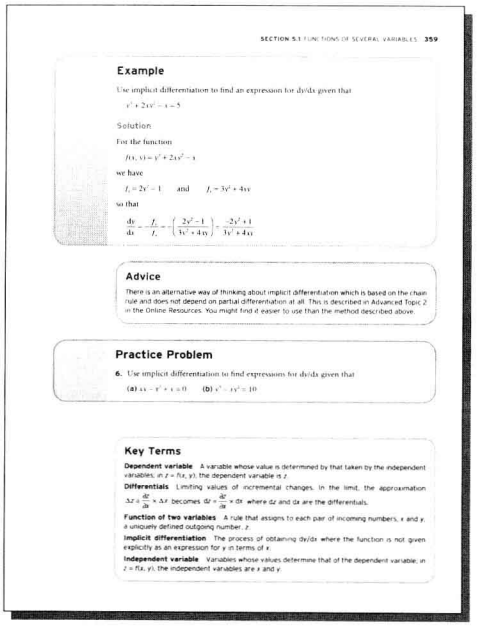
(a) 15% of 12

(b) 98% of 17

(c) 150% of 290

Section **Objectives** summarise what you should have learned by the end of the section.

AIDING YOUR UNDERSTANDING



SECTION 5.1 FUNCTIONS OF SEVERAL VARIABLES 359

Example

Use implicit differentiation to find an expression for dy/dx given that

$x^3 + 2xy^2 - x = 5$

Solution

For the function

$f(x, y) = x^3 + 2xy^2 - x$

we have

$f_x = 2y^2 - 1$ and $f_y = 3x^2 + 4xy$

so that

$$\frac{dy}{dx} = -\frac{f_x}{f_y} = -\left(\frac{2y^2 - 1}{3x^2 + 4xy}\right) = \frac{-2y^2 + 1}{3x^2 + 4xy}$$

Advice

There is an alternative way of thinking about implicit differentiation which is based on the chain rule and does not depend on partial differentiation at all. This is described in Advanced Topic 2 on the Online Resources. You might find it easier to use than the method described above.

Practice Problem

6. Use implicit differentiation to find expressions for dy/dx given that

(a) $4x - y^3 + x = 0$ (b) $x^3 - xy^2 = 10$

Key Terms

Dependent variable A variable whose value is determined by that taken by the independent variables; in $z = f(x, y)$, the dependent variable is z.

Differentials Limiting values of incremental changes. In the limit, the approximation $\Delta z \approx \frac{dz}{dx} \times \Delta x$ becomes $dz = \frac{dz}{dx} \times dx$ where dz and dx are the differentials.

Function of two variables A rule that assigns to each pair of incoming numbers, x and y, a uniquely defined outgoing number, z.

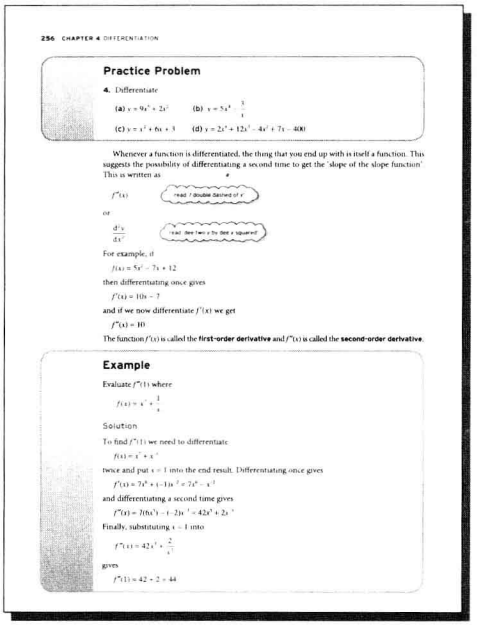
Implicit differentiation The process of obtaining dy/dx where the function is not given explicitly as an expression for y in terms of x.

Independent variable Variables whose values determine that of the dependent variable; in $z = f(x, y)$, the independent variables are x and y.

Key Terms are highlighted in colour when they are first appear in the text and collected together at the end of each section as well as in a Glossary on the website.

Advice boxes provide helpful hints and tips on mathematical techniques required to understand a particular section and suggest how you might best attempt individual sections.

TESTING YOUR UNDERSTANDING



256 CHAPTER 4 DIFFERENTIATION

Practice Problem

4. Differentiate

(a) $y = 9x^3 + 2x^2$ **(b)** $y = 5x^4 - \frac{3}{x}$

(c) $y = x^2 + 6x + 3$ **(d)** $y = 2x^5 + 12x^3 - 4x^2 + 7x - 400$

Whenever a function is differentiated, the thing that you end up with is itself a function. This suggests the possibility of differentiating a second time to get the 'slope of the slope function'. This is written as

$f''(x)$ — read 'f double dashed of x'

or

$\frac{d^2y}{dx^2}$ — read 'dee two y by dee x squared'

For example, if

$f(x) = 5x^3 - 7x + 12$

then differentiating once gives

$f'(x) = 10x - 7$

and if we now differentiate $f'(x)$ we get

$f''(x) = 10$

The function $f'(x)$ is called the **first-order derivative** and $f''(x)$ is called the **second-order derivative**.

Example

Evaluate $f''(1)$ where

$f(x) = x^4 + \frac{3}{x}$

Solution

To find $f''(1)$ we need to differentiate

$f(x) = x^4 + x^{-1}$

twice and put $x = 1$ into the end result. Differentiating once gives

$f'(x) = 7x^6 + (-1)x^{-2} = 7x^6 - x^{-2}$

and differentiating a second time gives

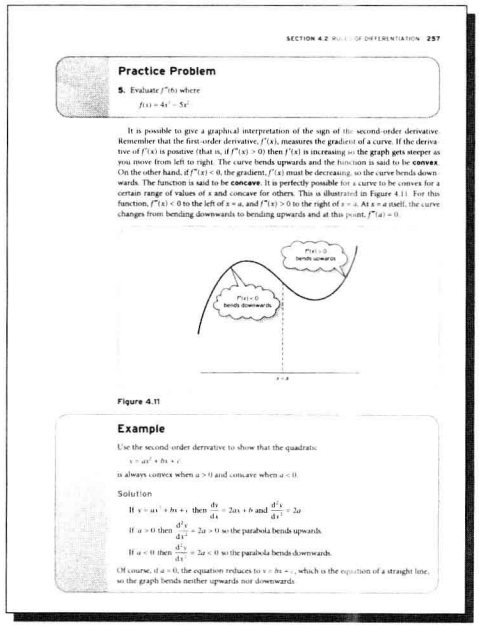
$f''(x) = 7(6x^5) - (-2)x^{-3} = 42x^5 + 2x^{-3}$

Finally, substituting $x = 1$ into

$f''(1) = 42x^5 + \frac{2}{x^3}$

gives

$f''(1) = 42 + 2 = 44$



SECTION 4.2 RULES OF DIFFERENTIATION 257

Practice Problem

5. Evaluate $f''(6)$ where

$f(x) = 4x^3 - 5x^2$

It is possible to give a graphical interpretation of the sign of the second-order derivative. Remember that the first-order derivative, $f'(x)$, measures the gradient of a curve. If the derivative of $f'(x)$ is positive (that is, if $f''(x) > 0$) then $f'(x)$ is increasing so the graph gets steeper as you move from left to right. The curve bends upwards and the function is said to be **convex**. On the other hand, if $f''(x) < 0$, the gradient, $f'(x)$ must be decreasing, so the curve bends downwards. The function is said to be **concave**. It is perfectly possible for a curve to be convex for a certain range of values of x and concave for others. This is illustrated in Figure 4.11. For this function, $f''(x) < 0$ to the left of $x = a$, and $f''(x) > 0$ to the right of $x = a$. At $x = a$ itself, the curve changes from bending downwards to bending upwards and at this point, $f''(a) = 0$.

Figure 4.11

Example

Use the second-order derivative to show that the quadratic

$y = ax^2 + bx + c$

is always convex when $a > 0$ and concave when $a < 0$.

Solution

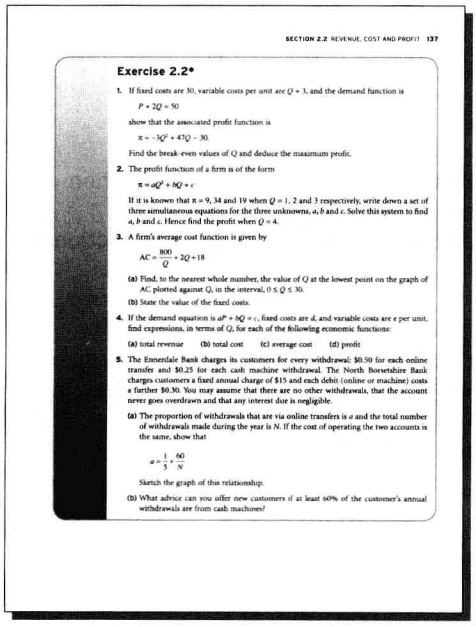
If $y = ax^2 + bx + c$, then $\frac{dy}{dx} = 2ax + b$ and $\frac{d^2y}{dx^2} = 2a$

If $a > 0$ then $\frac{d^2y}{dx^2} = 2a > 0$ so the parabola bends upwards.

If $a < 0$ then $\frac{d^2y}{dx^2} = 2a < 0$ so the parabola bends downwards.

Of course, if $a = 0$, the equation reduces to $y = bx + c$, which is the equation of a straight line, so the graph bends neither upwards nor downwards.

Practice Problems and **Examples.** The text is structured in short sections, each designed to take one to two hours of self-study time. Each section includes examples showing you the workings out followed by problems for you to test your understanding. Answers to the problems can be found on the book's website **www.pearsoned.co.uk/jacques.**



SECTION 2.2 REVENUE, COST AND PROFIT 137

Exercise 2.2*

1. If fixed costs are 30, variable costs per unit are $Q + 3$, and the demand function is

$P + 2Q = 50$

show that the associated profit function is

$\pi = -3Q^2 + 47Q - 30$.

Find the break-even values of Q and deduce the maximum profit.

2. The profit function of a firm is of the form

$\pi = aQ^2 + bQ + c$

If it is known that $\pi = 9$, 34 and 19 when $Q = 1$, 2 and 3 respectively, write down a set of three simultaneous equations for the three unknowns, a, b and c. Solve this system to find a, b and c. Hence find the profit when $Q = 4$.

3. A firm's average cost function is given by

$AC = \frac{800}{Q} + 2Q + 18$

(a) Find, to the nearest whole number, the value of Q at the lowest point on the graph of AC, plotted against Q, in the interval, $0 \leq Q \leq 30$.

(b) State the value of the fixed costs.

4. If the demand equation is $aP + bQ = c$, fixed costs are d, and variable costs are e per unit, find expressions, in terms of Q, for each of the following economic functions:

(a) total revenue **(b)** total cost **(c)** average cost **(d)** profit

5. The Ennerdale Bank charges its customers for every withdrawal: \$0.50 for each online transfer and \$0.25 for each cash machine withdrawal. The North Borsetshire Bank charges customers a fixed annual charge of \$15 and each debit (online or machine) costs a further \$0.30. You may assume that there are no other withdrawals, that the account never goes overdrawn and that any interest due is negligible.

(a) The proportion of withdrawals that are via online transfers is a and the total number of withdrawals made during the year is N. If the cost of operating the two accounts is the same, show that

$a = \frac{1}{5} + \frac{60}{N}$

Sketch the graph of this relationship.

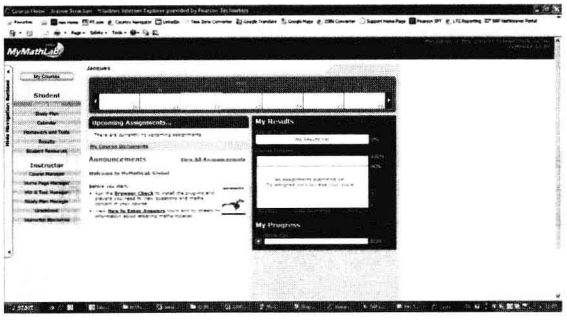
(b) What advice can you offer new customers if at least 60% of the customer's annual withdrawals are from cash machines?

End-of-section **Exercises** provide further opportunity to test your understanding. Starred * questions contain more challenging exercises to test you further.

CONTENTS

GUIDED TOUR OF THE ONLINE RESOURCES

MyMathLab Global is an online assessment and revision tool that puts you in control of your learning through a suite of study and practice tools tied to the Pearson eText.



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Since 2001, *MyMathLab Global*--along with MyMathLab, MyStatLab and MathXL, have helped over 9 million students succeed at more than 1,900 colleges and universities. *MyMathLab Global* engages students in active learning – it's modular, self-paced, accessible anywhere with web access, and adaptable to each student's learning style – and lecturers can easily customize *MyMathLab Global* to better meet their students' needs.

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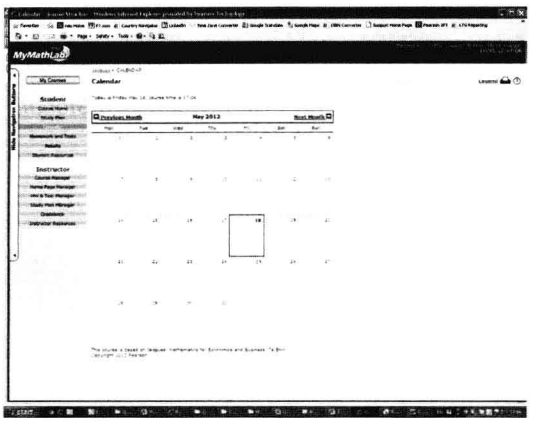
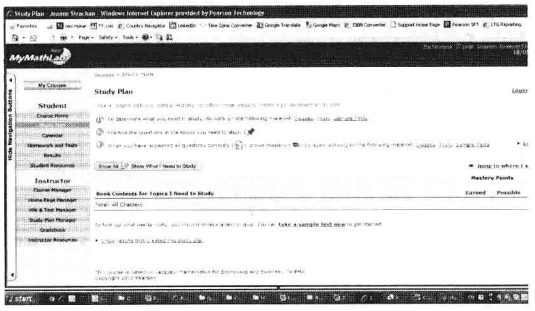
View the **Calendar** to see the dates for online homework, quizzes and tests that your lecturer has set for you.



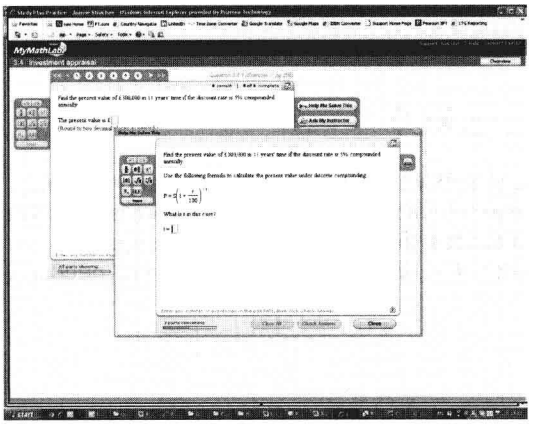
Your lecturer may have chosen *MyMathLab Global* to provide online **homework, quizzes and tests. Check** here to access the homework that has been set for you.

Keep track of your **results** in your own gradebook.

Work through the questions in your personalised **Study Plan** at your own pace. Because the Study Plan is tailored to each student, you will be able to study more efficiently by only reviewing areas where you still need practice. The Study Plan also saves your results, helping you see at a glance exactly which topics you need to review.



Additional instruction is provided in the form of detailed, step-by-step **solutions** to worked exercises. The figures in many of the exercises in *MyMathLab Global* are generated algorithmically, containing different values each time they are used. This means that you can practice individual problems as often as you like.



There is also a link to the **Pearson eText**, so you can easily review and master the content.

LECTURER TRAINING AND SUPPORT

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INTRODUCTION
Getting Started

NOTES FOR STUDENTS: HOW TO USE THIS BOOK

I am always amazed by the mix of students on first-year economics courses. Some have not acquired any mathematical knowledge beyond elementary algebra (and even that can be of a rather dubious nature), some have never studied economics before in their lives, while others have passed preliminary courses in both. Whatever category you are in, I hope that you will find this book of value. The chapters covering algebraic manipulation, simple calculus, finance, matrices and linear programming should also benefit students on business studies and management courses.

The first few chapters are aimed at complete beginners and students who have not taken mathematics courses for some time. I would like to think that these students once enjoyed mathematics and had every intention of continuing their studies in this area, but somehow never found the time to fit it into an already overcrowded academic timetable. However, I suspect that the reality is rather different. Possibly they hated the subject, could not understand it and dropped it at the earliest opportunity. If you find yourself in this position, you are probably horrified to discover that you must embark on a quantitative methods course with an examination looming on the horizon. However, there is no need to worry. My experience is that every student is capable of passing a mathematics examination. All that is required is a commitment to study and a willingness to suspend any prejudices about the subject gained at school. The fact that you have bothered to buy this book at all suggests that you are prepared to do both.

To help you get the most out of this book, let me compare the working practices of economics and engineering students. The former rarely read individual books in any great depth. They tend to visit college libraries (usually several days after an essay was due to be handed in) and skim through a large number of books picking out the relevant information. Indeed, the ability to read selectively and to compare various sources of information is an important skill that all arts and social science students must acquire. Engineering students, on the other hand, are more likely to read just a few books in any one year. They read each of these from cover to cover and attempt virtually every problem en route. Even though you are most definitely not an engineer, it is the engineering approach that you need to adopt while studying mathematics. There are several reasons for this. Firstly, a mathematics book can never be described, even by its most ardent admirers, as a good bedtime read. It can take an hour or two of concentrated effort to understand just a few pages of a mathematics text. You are therefore recommended to work through this book systematically in short bursts rather than to attempt to read whole chapters. Each section is designed to take between one and two hours to complete and this is quite sufficient for a single session. Secondly, mathematics is a hierarchical subject in which one topic follows on from the next. A construction firm building an office block is hardly likely to erect the fiftieth storey without making sure that the intermediate floors and foundations are securely in place. Likewise, you cannot 'dip' into the middle of a mathematics book and expect to follow it unless you have satisfied the prerequisites for that topic. Finally, you actually need to do mathematics yourself before you can understand it. No matter how wonderful your lecturer is, and no matter how many problems are discussed in class, it is only by solving problems yourself that you are ever going to become confident in using and applying mathematical techniques.