SOLUTIONS MANUAL

ENGINEERING ECONOMY

NINTH EDITION

◆

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WEB SITE CONTENTS

The web site associates with Engineering Economy, 9th ed., is available for students and instructors at the address (http://www.prenhall.com/thuesen). This material is intended to be utilized as a supplement to the textbook to enhance the users learning experience.

This web site contains a multimedia presentation that was developed with National Science Foundation support, the Economy 2.0 software package and access to the EzCash software package.

The interactive multimedia tutorial consists of eight modules that highlight the important principles of engineering economy. These principles are presented in the context of engineering design and the role of economic analysis in that process.

Economy 2.0 is an integrated software package for engineering economic analysis. Major functions of the package include interest formula calculations, cash flow analysis, band analysis, loan analysis, bases for comparison, forming mutually exclusive alternatives, replacement analysis, benefit-cost analysis, optimization analysis, after-tax analysis and sensitivity analysis. Examples of the use of their various functions are presented in Economy 2.0 for selected problems in Engineering Economy, 9th ed., Prentice Hall, 2001, by Thuesen and Fabrycky.

EzCash is an integrated economic software package that works on the Microsoft Windows operating system. It is designed to solve various engineering economy decision problems and tutor some of the basic concepts in engineering economy. In addition, it provides a spreadsheet work environment for a variety of economic analysis. For example, EzCash has a spreadsheet utility with many built in financial functions to facilitate after-tax cash flow analysis. Links to EzCash are provided.

FOREWORD AND CONTENTS

There are 581 questions and problems for solution in the Ninth Edition of ENGINEERING ECONOMY. These exercises provide practice in applying the concepts and principles of engineering economic analysis. Solutions of this manual are exhibited, as they would appear if developed on paper utilizing an electronic calculator.

CHAPTER 1

ENGINEERING AND ENGINEERING ECONOMY

1. The role of the scientist is to add to humankind's body of systematic knowledge and to discover universal laws of behavior. The role of the engineer is to apply this knowledge to particular situations to produce high quality, economically competitive products and services.

2. Physical laws are relatively more exact than economic laws. This is because economics deals with the actions of people that are not based on logical, well-ordered processes.

3. The engineer's approach to the solution of problems has broadened to such an extent that success may depend as much upon the ability to cope with economic aspects as it does with physical aspects of the total environment.

4. Some examples are: a system of reflectors to collect solar energy for cooking purposes; a one person helicopter for commuters; an electrically heated suit of clothes powered by batteries.

5. Economic efficiency is expressed as worth divided by cost. If economic worth is high relative to economic cost, a system with low physical efficiency may have an economic efficiency greater than 100 percent.

6. The success of an undertaking is evaluated in terms of its economic efficiency, with physical efficiency being of secondary importance.

7. The physical aspect of engineering application is decreasing in relative importance because the development of technology has made goods and services physically possible that people may be interested in only slightly, or not at all, because of cost and other factors.

8. Seeking new objectives for engineering application is creative in nature and requires knowledge of physical limitations, as well as an understanding of human nature.

9. Those factors, which stand in the way of attaining objectives, are known as limiting factors. Factors that, if altered, will remove limitations restricting the success of an undertaking are known as strategic factors. An example of a limiting factor is the energy content of a fuel; a strategic factor is the design efficiency with which combustion takes place.

10. Engineering education provides an understanding of the physical environment together with a capability in analysis useful in determining means for circumventing strategic factors not ordinarily acquired in other areas of study.

11. Engineers may assist in decision making by providing a logical determination and evaluation of alternatives in tangible terms and by identifying alternative courses of action unknown to the decision maker.

12. Decision is only necessary for action to be taken in the future. The differences in contemplated courses of action relative to outcome in the future provide the basis for all decisions.

13. Estimates are used because some facts that apply to the future are unknown, cannot be obtained, or do not exist.

14. Before an action can be initiated, there must be a decision to act. Since the outcome of a course of action can never be completely determined by the application of reason to facts, judgment must be used to arrive at a conclusion.
15. It is not possible to consider all alternatives because of the cost involved and because the time that passes during the process may make the contemplated action worthless.

16. Judgment is an informal consideration of the facts of a situation in which emotional evaluation is a part of the process of coming to a conclusion. It is applicable to more situations than reason because most situations involve facts that are not fully quantified and completely related to the outcome.

17. The competitiveness of a product is determined largely in economic terms. Although performance and quality are important in product competitiveness, economic feasibility must be satisfied as a prerequisite for success in the market place.

18. Specific situation not given. Suggest answer be given in terms of the life-cycle activities identified in Figure 1.2

19. Designing for the life-cycle recognizes design as the "cause" for downstream "effects". Successful design manifests itself as desirable outcome during the utilization phase of the life-cycle.

20. It is generally easier for the engineer to master the fundamental concepts of economic analysis necessary to bridge the gap between physical and economic aspects of engineering application than it is for a person who is not technically trained to acquire the necessary technical background.

21. A responsive engineer acts on the initiative of others, whereas the creative engineer not only seeks to overcome physical limitations, but also accepts responsibility for the success of projects involving economic and human factors.

CHAPTER 2

SOME ECONOMIC AND COST CONCEPTS

1. Value is the worth that a person attaches to a good or service. Utility is the power of a good service to satisfy human wants.

2. Utilities are produced or created by altering the physical environment.

3. Consumer goods and services directly satisfy human wants. Producer goods and services are a means to an end; namely, that of producing goods and services for human consumption.

4. The utility of consumer goods is determined by an individual who intends to consume them directly for the satisfaction derived. The utility of a producer good is not based on direct satisfaction of a want, but is based on its use as a means for producing consumer goods.

5. Consumer goods satisfy the needs of individuals who evaluate their needs subjectively. On the other hand, producer goods are valued as a means of producing consumer goods by altering the physical environment. The utility of altering the physical factors can be evaluated more objectively.

6. Economy of exchange occurs when utilities are exchanged by two or more people. Exchange takes place because the utilities are evaluated almost entirely, if not entirely, buy subjective considerations.

7. Both parties to an exchange may profit because each is in a different economic environment and each evaluates the objects to be exchanged subjectively.

8. An attitudinal change may be brought about by persuasion in an exchange situation.

9. First cost is made up of the purchase price, shipping cost, installation cost, and possibly operator training cost. For a fabricated item, first cost would also include design, development, and construction or production cost.

10. Many engineering proposals that are otherwise sound are not implemented because the first cost involved is beyond the reach of the organization.

11. Operation and maintenance cost is made up of the costs for personnel, fuel and power, supplies, spare and repair parts, insurance and taxes, and a fair share of indirect or overhead cost.

12. Nonrecurring costs are those associated with getting an activity started, whereas recurring costs are those incurred to continue the activity once initiated.

13. Both the cost of acquisition and operation should be considered in the purchase of an air conditioner. By paying more initially, a more efficient unit might be acquired leading to a lower life-cycle cost.

14. Fixed cost is that group of costs involved in a going activity whose total will remain relatively constant throughout the range of operational activity. Variable cost is that group of costs which vary in some relationship to the level of activity.

15. Whether a cost is fixed or variable depends on how the cost varies with the range of activities of an enterprise. Thus, types of costs which are fixed for one firm may be variable for another.

16. An incremental cost is an increase in cost which occurs as a result of an incremental change in an activity level.

CHAPTER 2 - SOME ECONOMIC AND COST CONCEPTS

17. Sunk costs are costs that have been incurred at some past date. Because decision-makers cannot control the past, the only costs that are relevant for decision purposes are those affected by present or future actions.

18. Life-cycle cost is the aggregate of the cost of acquisition, the utilization costs such as maintenance and operation, and the cost of phaseout and disposal.

19. Cost is committed at future points in the life-cycle as a consequence of decisions made at earlier points in time. Committed life-cycle cost will exceed actual cost incurred until the end of the life cycle when all cost is committed and all incurred cost is recorded by the accounting system.

20. Early life-cycle activities and decisions are the cause of costs to be incurred in the future. The committment is greatest during the early phases of the life cycle and so great care should be exercised.

21. Interest is the amount charged for the use of funds, whereas an interest rate is the charge expressed as a percent per time period.

22. The market rate for interest is the rate established by market forces of supply and demand. It is determined by mutual agreement.

23. A lender will consider the probability that a borrower will not repay, the expenses incurred in loan administration, the compensation needed to offset being unable to use the money in other ways, and inflationary effects.

24. Because the interest charged is determined by a rate keyed to time, money has time value. A dollar in the future is worth less than a dollar now because of the time dependent interest rate.

25. Money has earning power because it may be used to acquire capital equipment which may increase productivity.

26. High interest rates add to the cost of capital equipment. This tends to offset the extra earnings made possible by increased productivity.

CHAPTER 3

INTEREST FORMULA DERIVATIONS

1. F = $5,000 [1 + 0.10(5)] = $7,500

2. $500 + $500(0.10)n = $625; n = 2.5 years

3. P + P (0.12)(4.25) = $14,000; P = $9,272

4. Simple interest:
   $5,000(0.15)(5) = $3,750

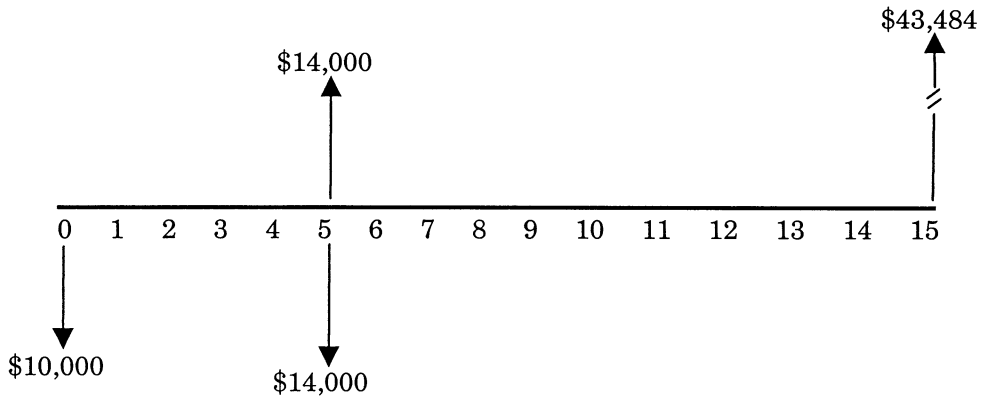
   Compound interest:
   $$\$5{,}000(\underset{F/P,15,5}{2.011}) - \$5{,}000 = \$5{,}055$$

5. $8,000 (i)(2/12) = $160; i = 12%

6. F = $2,000 [1 + 0.09(60/365)] = $2,030

7. $$[\$10{,}000 + \$10{,}000(0.08)(5)](\underset{F/P,12,10}{3.106}) = \$43{,}484$$

8. Cash Flow Diagram:



9. (a) $$P = \$2{,}000(\underset{P/F,10,3}{0.7513}) = \$1{,}503$$
   (b) $$F = \$50{,}000(\underset{P/F,10,6}{1.772}) = \$88{,}600$$

10. (a) $5,000(F/P,13,8) = $5,000(2.658) = $13,290

(b) $1,500(F/P,15,15) = $1,500(8.137) = $12,206

(c) $20,000(F/P,16,38) = $20,000(281.45) = $5,629,030

(d) $3,500(F/P,9,70) = $3,500(416.730) = $1,458,555

(e) $5,500(F/P,10.5,35) = $5,500(32.936) = $181,148

(f) $9,000(F/P,7,145) = $9,000(18,225.17) = $164,017,530

11. (a) $18,000(P/F,8,5) = $18,000(0.6806) = $12,251

(b) $8,500(P/F,12,12) = $8,500(0.2567) = $2,182

(c) $6,500(P/F,15,52) = $6,500(0.0007) = $4.55

(d) $16,000(P/F,10.5,63) = $16,000(0.0019) = $30.40

(e) $13,000(P/F,13,15) = $13,000(0.1599) = $2,079

(f) $5,500(P/F,8.5,10) = $5,500(0.4422) = $2,432

12. (a) $600(F/A,10,5) = $600(6.105) = $3,663

(b) $1,500(F/A,15,8) = $1,500(13.727) = $20,590

(c) $4,200(F/A,12,42) = $4,200(964.359) = $4,050,308

(d) $110(F/A,11,100) = $110(309,665.23) = $34,063,175

(e) $250(F/A,12.5,25) = $250(144.021) = $35,005

(f) $900(F/A,9.5,45) = $900(614.519) = $553,067

13. (a) $\$65{,}000(\ {}^{A/F,15,15}_{0.0210}\ ) = \$1{,}365$

(b) $\$6{,}500(\ {}^{A/F,11,7}_{0.1022}\ ) = \$664$

(c) $\$13{,}000({}^{A/F,13,58}_{0.000109}) = \$1.42$

(d) $\$2{,}000(\ {}^{A/F,11,6}_{0.1264}\ ) = \$253$

(e) $\$5{,}200(\ {}^{A/F,8.2,42}_{0.0031}\ ) = \$16.12$

(f) $\$90{,}000(\ {}^{A/F,6.5,75}_{0.00058}\ ) = \$52.45$

14. (a) $\$1{,}500(\ {}^{P/A,15,15}_{5.8474}\ ) = \$8{,}771$

(b) $\$250(\ {}^{P/A,10,35}_{9.6442}\ ) = \$2{,}411$

(c) $\$900(\ {}^{P/A,9,9}_{5.9953}\ ) = \$5{,}396$

(d) $\$2{,}000(\ {}^{P/A,12,10}_{5.6502}\ ) = \$11{,}300$

(e) $\$1{,}200(\ {}^{P/A,14.5,42}_{6.8731}\ ) = \$8{,}248$

(f) $\$11{,}000(\ {}^{P/A,7.5,7}_{5.2966}\ ) = \$58{,}263$

15. (a) $\$5{,}000(\ {}^{A/P,15,5}_{0.2983}\ ) = \$1{,}492$

(b) $\$45{,}000(\ {}^{A/P,9.5,9}_{0.1702}\ ) = \$7{,}659$

(c) $\$10{,}000(\ {}^{A/P,10,15}_{0.1315}\ ) = \$1{,}315$

(d) $\$35{,}000(\ {}^{A/P,5,65}_{0.0522}\ ) = \$1{,}827$

(e) $\$11{,}000(\ {}^{A/P,11.5,100}_{0.1150}\ ) = \$1{,}265$

(f) $\$120{,}000(\ {}^{A/P,10.4,30}_{0.1096}\ ) = \$13{,}152$

16. (a) $A = \$2{,}000 + \$100(\ {}^{A/G,10,7}_{2.6216}\ ) = \$2{,}262$

(b) $A = \$250 + \$50(\ {}^{A/G,9,30}_{8.6657}\ ) = \$683$

(c) $A = \$400 + \$200(\ {}^{A/G,12.5,25}_{6.6113}\ ) = \$1{,}722$

CHAPTER 3 - INTEREST FORMULA DERIVATIONS

17. (a) $A = \$6{,}000 - \$200(\ A/G,12,10\ 3.5847\ ) = \$5{,}283$

(b) $A = \$10{,}000 - \$100(\ A/G,8,42\ 10.774\ ) = \$8{,}923$

(c) $A = \$1{,}500 - \$40(\ A/G,14.3,19\ 5.3653\ ) = \$1{,}285$

18. (a) $g' = [(1+0.17)/(1 - 0.10)] - 1 = 0.30$

$P = \$9{,}000[(\ P/A,30,10\ 3.0915\ )/(1-0.10)] = \$30{,}915$

(b) $g' = [(1+0.15)/(1 - 0.25)] - 1 = 0.5333$

$P = \$1{,}000{,}000[(\ P/A,53.33,4\ 1.5359\ )/(1-0.25)] = \$2{,}047{,}866$

(c) $g' = [(1+0.135)/(1 - 0.086)] - 1 = 0.2418$

$P = \$200{,}000[(\ P/A,24.18,41\ 4.1351\ )/(1-0.086)] = \$904{,}836$

19. (a) $g' = [(1+0.12)/(1+0.04)] - 1 = 0.0769 = 7.69\%$

$P = \$900[(\ P/A,7.69,10\ 6.8049\ )/(1+0.05)] = \$5{,}889$

(b) $g' = [(1+0.13)/(1+0.10)] - 1 = 0.0273$

$P = \$15{,}000[(\ P/A,2.73,8\ 7.1012\ )/(1+0.10)] = \$96{,}835$

(c) $g' = 0$

$P = \$1{,}000[20/(1+0.08)] = \$18{,}519$

20. $A = \$200(\ A/G,13,10\ 3.5162\ ) = \$703$

21. Find the smallest integer value of n for which $2 \leq (\ F/P, i, n\ )$

(a) 24 years
(b) 12 years
(c) 7 years
(d) 6 years
(e) 4 years
(f) 3 years

22. $2 = (1+i)^n$

$n = \log(2)/\log(1+i)$; Plot not shown.

23. $\$1{,}000(\ F/P,i,12\ ) = \$4{,}000$; $i = 12.25\%$

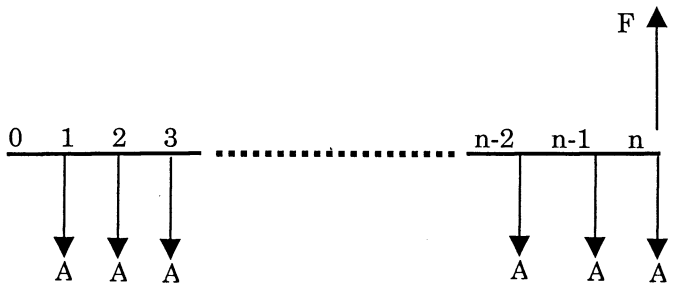
24. $\$1{,}000(\ \ F/P,8,n\ \ ) = \$5{,}000;\quad n = 21$ years

25. Find i for a given n from $3 = (\ \ F/P,i,n\ \ )$
    (a) 31.60%
    (b) 20.10%
    (c) 12.98%
    (d) 8.81%
    (e) 4.49%
    (f) 3.19%

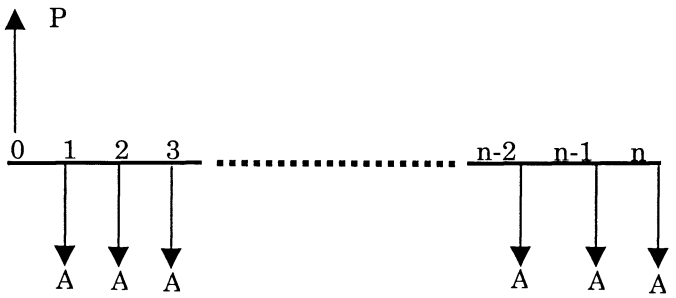
26. (a) $\$23{,}670 = \$10{,}000(\ F/P,i,10\ =\ 2.367\ );\ i = 9\%$
    (b) $\$4{,}000 = \$1{,}000(\ F/P,i,18\ =\ 4.000\ );\ i = 8\%$
    (c) $\$4{,}212 = \$2{,}500(\ F/P,i,5\ =\ 1.6848);\ i = 11\%$
    (d) $\$36{,}000 = \$9{,}000(\ F/P,i,20\ =\ 4.000\ );\ i = 7.18\%$

27. $$F = G\left[\frac{(1+i)^n - 1}{i^2} - \frac{n}{i}\right] = G\left[\frac{1}{i}(\ F/A,i,n\ ) - \frac{n}{i}\right]$$

28. (F/A, i, n)



29. 29.(A/P, i, n)



CHAPTER 3 - INTEREST FORMULA DERIVATIONS

30. $P = G(\underset{}{A/G,i,n})(\underset{}{P/A,i,n}) = G\left\{\frac{1}{i} - \frac{n}{i}\left[\frac{i}{(1+i)^n-1}\right]\right\}\left[\frac{(1+i)^n-1}{i(1+i)^n}\right]$

31. (a) $\$6{,}939 = \$3{,}000(\underset{}{F/P,15,n})$; $n = 6$
    (b) $\$7{,}400 = \$1{,}000(\underset{}{F/P,10,n})$; $n = 21$
    (c) $\$302{,}100 = \$5{,}000(\underset{}{F/P,6,n})$; $n = 70.4$
    (d) $\$2{,}824 = \$200(\underset{}{F/P,12.2,n})$; $n = 23$

32. $F = P(1 + \frac{r}{p})^{py}$

33. $F = \sum_{t=1}^{n} B(1+i)^t = B(1+i)\sum_{t=0}^{n}(1+i)^t = \frac{B(1+i)[(1+i)^n-1]}{i}$

34. (a) $i = (1 + \frac{0.12}{2})^2 - 1 = 0.1236$
    (b) $i = (1 + \frac{0.12}{12})^{12} - 1 = 0.1268$
    (c) $i = (1+\frac{0.12}{4})^4 - 1 = 0.1255$
    (d) $i = (1 + \frac{0.12}{52})^{52} - 1 = 0.1273$
    (e) $i = (1 + \frac{0.12}{365})^{365} - 1 = 0.1274$

35. (a) r = 12%; i = 6% per six months
    (b) r = 4%; i = 1% per quarter
    (c) r = 17%; i = 1.416% per month
    (d) r = 26%; i = 0.5% per week
    (e) r = 7.70%; i = 0.0211% per day
    (f) r = 115.05%; i = 9.59% per month

36. (a) $i = \frac{0.08}{2} = 0.04$ per six months
    (b) $i = \frac{0.12}{4} = 0.03$ per quarter
    (c) $i = \frac{0.09}{12} = 0.0075$ per month
    (d) $i = \frac{0.18}{365} = 0.000493$ per day
    (e) There is no effective rate per period for continuous compounding.

CHAPTER 3 - INTEREST FORMULA DERIVATIONS

37. (a) $\$17{,}000 = \$4{,}500(\ P/A,i,6\ 3.778\ );$ $i = 15.065\%,$ $r = 15.065\%$

    (b) $\$25{,}000 = \$1{,}000(\ P/A,i,10\ 25.000\ );$ $i = 19.240\%,$ $r = 19.240\%$

38. $i = (1 + 0.003)^{52} - 1 = 16.855\%$ effective per year
    $r = 15.6\%$ compounded weekly

39. (a) $0.12 = (1 + r/2)^{2} - 1;\ r = 11.66\%$
    (b) $0.12 = (1 + r/4)^{4} - 1;\ r = 11.49\%$

40. $i = (1 + 0.18/12)^{12} - 1 = 19.56\%$

    $\frac{19.56\%}{18.00\%} = 1.087$ times as desirable

41. (a) $0.083246 < 0.09;$ 9% compounded annually
    (b) $0.115718 < 0.1236;$ 12% compounded semiannually
    (c) $0.209169 > 0.20;$ 19% compounded daily
    (d) $0.283250 > 0.276900;$ 25% compounded weekly
    (e) $0.37137 < 0.373130;$ 33% compounded quarterly
    (f) $0.453693 > 0.430000;$ 38% compounded monthly

42. (a) $0.1052 = e^{r} - 1;$ $r = 10.00\%$
    (b) $0.1502 = e^{r} - 1;$ $r = 14.00\%$
    (c) $0.12 = e^{r} - 1;$ $r = 11.33\%$
    (d) $0.31 = e^{r} - 1;$ $r = 27.00\%$
    (e) $0.16 = e^{r} - 1;$ $r = 14.84\%$
    (f) $0.50 = e^{r} - 1;$ $r = 40.55\%$

43. $i = e^{0.12} - 1 = 0.1275$ or 12.75%
    $0.08 = e^{r} - 1;\ r = 7.7\%$

44. (a) $2 = e^{(0.02)n};$ $n = 34.65$ years
    (b) $2 = e^{(0.04)n};$ $n = 17.32$ years
    (c) $2 = e^{(0.08)n};$ $n = 8.66$ years
    (d) $2 = e^{(0.12)n};$ $n = 5.77$ years
    (e) $2 = e^{(0.14)n};$ $n = 4.95$ years
    (f) $2 = e^{(0.16)n};$ $n = 4.33$ years

45. $A = \$60{,}000[\ \overset{A/F,13,20}{0.0111}\ ] = \$666$

46. $A = \$2{,}500\left[\dfrac{e^{0.08}-1}{1-e^{-0.08(3)}}\right] = \$2{,}500[\ \overset{A/P,8,3}{0.3903}\ ] = \$976$

47. $P = \$1{,}400[\ \overset{P/A,12.7,10}{5.3108}\ ] = \$7{,}435$

48. (a) $P = \$9{,}000[\ \overset{P/A,6,7}{5.5461}\ ] = \$49{,}915$

(b) $P = \$700[\ \overset{P/A,12,10}{5.481}\ ] = \$3{,}836$

(c) $P = \$400[\ \overset{P/A,8,14}{8.0891}\ ] = \$3{,}236$

(d) $P = \$2{,}300[\ \overset{P/A,16,16}{5.3178}\ ] = \$12{,}230$

49. (a) $P = \$7{,}500[\ \overset{P/F,10,30}{0.0498}\ ] = \$373.50$

(b) $P = \$9{,}200(\ \overset{P/F,12/52,260}{0.5492}\ ) = \$5{,}053$

50. (a) $F = \$400[\ \overset{F/A,9.8,5}{6.1412}\ ] = \$2{,}456$

(b) $F = \$500\left[\dfrac{e^{0.15(39)}-1}{e^{0.15}-1}\right]$

$= \$500[\ \overset{F/A,15,39}{2139.44}\ ] = \$1{,}069{,}720$

51. (a) $F = \$900[\ \overset{F/A,10,6}{7.817}\ ] = \$7{,}035$

(b) $F = \$6{,}000[\ \overset{F/A,9,21}{59.670}\ ] = \$358{,}020$

52. $\$5{,}600\left[\dfrac{e^{r(29)}-1}{e^{r}-1}\right] = \$500{,}000\,;$ $\quad r = 6.90\%$

53. $\$18{,}300 = \$4{,}300[\ P/A, r, 15\ ]$ $\quad\quad$ $r = 20.2\%$

54. $\$30{,}000 = \$8{,}000[\ P/A, 10, n\ ];$ $\quad\quad$ $n = 5$

55. $\$40{,}000 = \$8{,}000[\ P/A, 15, n\ ]$

$n = 11.042$ years $\quad$ ===> $\quad\quad$ $n = 12$ years (smallest integer where A > \$8,000)

$$\$41{,}262 = \$8{,}000\left[\frac{1-e^{-0.15(12)}}{e^{0.15}-1}\right];$$

56. $\$100{,}000 = \$1{,}600[\ F/A, 20, n\ ]$

$n = 13.486$ years $\quad$ ===> $\quad\quad$ $n = 14$ years (smallest integer where F > \$100,000)

$$\$1{,}600\left[\frac{e^{0.20(14)}-1}{e^{0.20}-1}\right] = \$111{,}613$$

CHAPTER 4

CALCULATING ECONOMIC EQUIVALENCE

1. (a) $\$1{,}000(\ P/F,7,10\ 0.5083\ ) = \$508$

(b) $\$9{,}000(\ P/F,2,40\ 0.4529\ ) = \$4{,}076$

(c) $\$25{,}000(\ P/F,3/4,96\ 0..4881\ ) = \$12{,}202$

(d) $\$105{,}000(\ P/F,0.25,624\ 0.2105\ ) = \$22{,}103$

2. (a) $\$1{,}500(\ F/P,6,10\ 1.7908\ ) = \$2{,}686$

(b) $\$5{,}000(\ F/P,4,36\ 4.1039\ ) = \$20{,}520$

(c) $\$1{,}500(\ F/P,1/2,156\ 2.1772\ ) = \$3{,}266$

(d) $\$4{,}500(\ F/P,13/365,5475\ 7.0262\ ) = \$4{,}500(\ F/P,13.88,15\ 7.0262\ ) = \$31{,}618$

3. (a) $\$13{,}000(\ A/P,2,24\ 0.0529\ ) = \$688$

(b) $\$20{,}000(\ A/P,1.25,24\ 0.0485\ ) = \$970$

(c) Effective interest rate per semiannual period = $(1+0.10/4)^2 - 1 = 0.0506$

$\$6{,}000(\ A/P,5.06,8\ 0.1551\ ) = \$931$

(d) $\$10{,}000(\ A/P,0.75,50\ 0.0241\ ) = \$241$

(e) Quarterly payments = (Annual payments)/4

$\$1{,}500(\ A/P,13,5\ 0.2843\ ) = \$426$ per year $\Rightarrow$ \$107 per quarter

4. (a) $\$8{,}000(\ A/F,8,12\ 0.0527\ ) = \$422$

(b) $\$4{,}000(\ A/F,6.14,12\ 0.0588\ ) = \$235$

(c) $\$25{,}000(\ A/F,3.03,40\ 0.0132\ ) = \$329$

(d) $\$15{,}000(\ A/F,8.16,5\ 0.1699\ ) = \$2{,}549$

(e) Monthly payments = (Quarterly payments)/3

$\$70{,}000(\ A/F,5,28\ 0.0171\ ) = \$1{,}199$ per quarter $\Rightarrow$ \$ 399.53 per month

5. (a) $P = 12(\$600)(\underset{P/A,13,3}{2.3612}) = \$17,001$

(b) $P = \$5,000(\underset{P/A,16.64,5}{3.2260}) = \$16,130$

(c) $P = \$2,500(\underset{P/A,8.24,10}{6.6371}) = \$16,593$

(d) $P = \$14,000(\underset{P/A,3.03,16}{12.5322}) = \$175,451$

6. (a) $F = 3(\$1,300)(\underset{F/A,2,20}{24.2974}) = \$31,587$

(b) $F = 2(\$600)(\underset{F/A,8,8}{10.6366}) = \$12,764$

(c) $F = \$19,000(\underset{F/A,12.55,3}{3.3923}) = \$64,453$

(d) $F = \$5,000(\underset{F/A,3.04,20}{26.9738}) = \$134,869$

7. $A = \$16,000 - \$500(\underset{A/G,10,15}{5.2789}) = \$9,361$

8. (a) $A = \$600 + \$200(\underset{A/G,12,7}{2.5515}) = \$1,110$

(b) $A = \$600 + \$200[\underset{A/G,12,7}{2.5257}] = \$1,105$

9. (a) $A = \$3,200 - \$600(\underset{A/G,10,5}{1.8101}) = \$2,114$

(b) $A = \$3,200 - \$600[\underset{A/G,10,5}{1.8009}] = \$2,119$

10. (a) $i_a = e^{0.17} - 1 = 0.1853$; $g' = [(1.1853)/(1.04)] - 1 = 0.1397$

$P = \$4,000(\underset{P/A,13.97,15}{6.1514})/(1.04) = \$23,659$

(b) $i_a = e^{0.06} - 1 = 0.618$; $g' = [(1.0618)/(1.10)] - 1 = -0.0347$

$P = \$100(\underset{P/A,-3.47,12}{15.2089})/(1.10) = \$1,383$

(c) $i_a = e^{0.19} - 1 = 0.2092$; $g' = [(1.2092)/(1.07)] - 1 = 0.1301$

$P = \$7,000(\underset{P/A,13.01,20}{7.0205})/(1.07) = \$45,929$

11. (a) $i_a = e^{0.09} - 1 = 0.0942$; $g' = [(1.0942)/(0.97)] - 1 = 0.1280$

$P/A,12.80,7$

$P = \$10,000(\quad 4.4503 \quad)/(0.97) = \$45,879$

(b) $i_a = e^{0.08} - 1 = 0.0833$; $g' = [(1.0833)/(0.86)] - 1 = 0.2597$

$P/A,25.97,30$

$P = \$20,000(\quad 3.8468 \quad)/(0.86) = \$89,460$

(c) $i_a = e^{0.20} - 1 = 0.2214$; $g' = [(1.2214)/(0.85)] - 1 = 0.4369$

$P/A,43.69,10$

$P = \$40,000(\quad 2.2279 \quad)/(0.85) = \$10,484$

12. (a) 4.68% per quarter, $i_a = (1+0.0468)^4 - 1 = 0.201 = 20.1\%$ per year ;

$r = 4(0.0468) = 0.1873 = 18.73\%$ compounded quarterly

(b) 2.83% per quarter, $i_a = (1+0.0283)^4 - 1 = 0.119 = 11.9\%$ per year ;

$r = 4(0.0283) = 0.113 = 11.3\%$ compounded quarterly

(c) 2.47% per quarter, $i_a = (1+0.0247)^4 - 1 = 0.103 = 10.3\%$ per year ;

$r = 4(0.0247) = 0.0989 = 9.89\%$ compounded quarterly

(d) -3.60% per quarter, $i_a = (1 - 0.036)^4 - 1 = - 0.136 = - 13.6\%$ per year ;

$r = 4(-0.0360) = - 0.144 = - 14.4\%$ compounded quarterly

13. (a) $F/A,i,8$

$\$5,000 = \$500(\quad)$; $i = 6.287\%$ per year

$i = (1.06287)^{1/12} - 1 = 0.509\%$ per month;

$r = (12)(0.509\%) = 6.113\%$ compounded monthly

(b) $F/A,i,48$

$\$16,500 = \$299(\quad)$; $i = 0.581\%$ per month

$i = (1.00581)^{12} - 1 = 7.20\%$ per year;

$r = (12)(0.581\%) = 6.927\%$ compounded monthly

(c) $F/A,i,52$

$\$18,000 = \$250(\quad)$; $i = 1.219\%$ per quarter

$i = (1.0121)^{1/3} - 1 = 0.405\%$ per month;

$i = (1.00405)^{12} - 1 = 4.97\%$ per year;

$r = (12)(0.405\%) = 4.86\%$ compounded monthly

(d) $F/A,i,24$

$\$36,000 = \$800(\quad)$; $i = 5.09\%$ per six months

$i = (1.0509)^{1/6} - 1 = 0.83\%$ per month;

$i = (1.0083)^{12} - 1 = 10.43\%$ per year;

$r = (12)(0.83\%) = 9.96\%$ compounded monthly

14. (a) $\$6,000 = \$800(P/A,i,8)$; $i = 1.47\%$ per six-months
$i = (1.0147)^2 - 1 = 2.96\%$ per year;
$r = (2)(1.47\%) = 2.94\%$ compounded semiannually

(b) $\$12,000 = \$3,000(P/A,i,6)$; $i = 13.0\%$ per six-months
$i = (1.13)^2 - 1 = 27.69\%$ per year;
$r = (2)(13\%) = 26.0\%$ compounded semiannually

(c) $\$8,000 = \$800(P/A,i,12)$; $i = 2.925\%$ per year
$i = (1.0295)^{1/2} - 1 = 1.452\%$ per six-months;
$r = (2)(1.452\%) = 2.904\%$ compounded semiannually

(d) $\$10,000 = \$1,687(P/A,i,20)$; $i = 16\%$ per year
$i = (1.16)^{1/2} - 1 = 7.70\%$ per six-months;
$r = (2)(7.70\%) = 15.4\%$ compounded semiannually

15. $P = \$1,600(P/A,2,100) = \$1,600(43.0984) = \$68,957$

$P = \$1,600[P/A,2,100] = \$1,600[42.8024] = \$68,484$

16. $P = (4)\$720(P/A,18,10) = (4)\$720(4.494) = \$12,943$

$P = \$720(P/A,4.5,40) = \$720(18.4016) = \$13,249$

$P = \$720[P/A,4.5,40] = \$720[18.1347] = \$13,057$

17. $F = \$4,400(F/A,12,5) = \$4,400(6.353) = \$27,953$

$F = \$4,400(F/A,12.68,5) = \$4,400(6.4396) = \$28,334$

$F = \$4,400[F/A,12,5] = \$4,400[6.4481] = \$28,372$ or $F = \$4,400(F/A,12.75,5) = \$4,400(6.4481) = \$28,372$

18. $\$2,030 = \$15,000[A/P,10,n]$

$[A/P,10,n] = 0.135$; $n = 15$ years Using Equation 3.21 and solving for n

CHAPTER 4- CALCULATING ECONOMIC EQUIVALENCE

19. $P = \$750[\ \overset{P/A,8,10}{6.612}\ ] = \$4,959$

$A = \$4,959[\ \overset{A/P,8,12}{0.135}\ ] = \$669$

20. (a) $P = \$1,200(\ \overset{P/A,8,100}{12.4943}\ ) = \$14,993$

(b) $F = \$12(\overset{F/A,8,100}{27,484.25}) = \$329,814$

(c) $A = \$1,000,000(\ \overset{A/F,8,100}{0.00004}\ ) = \$36$

(d) $A = \$120,000(\ \overset{A/P,8,100}{0.080}\ ) = \$9,604$

21. (a) $P = \$130(\ \overset{P/A,6,20}{11.4699}\ ) = \$1,491$

(b) $A = \$18,000(\ \overset{A/F,6,18}{0.0323}\ ) = \$582$

22. $P = (0.9)[50,000 - 10,000(\ \overset{A/G,12,5}{1.7746}\ )](\ \overset{P/A,12,5}{3.6048}\ )(\$4) = \$418,569 > \$400,000$

23. $A = \$60,000(\ \overset{A/F,16,12}{0.0324}\ ) = \$1,944$

24. $P = [\$10,000 - \$1,000(\ \overset{A/G,10,5}{1.8101}\ )](\ \overset{P/A,10,5}{3.7908}\ ) = \$31,046$

Compounding continuously, r = 10%

$P = [\$10,000 - \$1,000[\ \overset{A/G,r,5}{1.8009}\ ]][\ \overset{P/A,r,5}{3.7412}\ ] = \$30,674$

25. (a) $P = \$300(\ \overset{P/A,3,24}{16.9356}\ ) + \$600(\ \overset{P/A,3,32}{20.388}\ )(\ \overset{P/F,3,24}{0.4919}) = \$11,098$

(b) $P = \$300(\ \overset{P/A,3.03,24}{16.8809}\ ) + \$600(\ \overset{P/A,3.03,32}{20.3058}\ )(\ \overset{P/F,3.03,24}{0.4885}\ ) = \$11,016$

(c) $P = \$300[\ \overset{P/A,3,24}{16.8529}\ ] + \$600[\ \overset{P/A,3,32}{20.2632}\ ][\ \overset{P/F,3,24}{0.4868}\ ] = \$10,974$

26. $F = \$1,000(\ \overset{P/A,7,12}{7.9427}\ )(\ \overset{F/P,7,5}{1.403}\ ) = \$11,144$

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27. $\$7{,}500(\underset{P/A,15,10}{5.0188}) = x[(\underset{P/F,15,6}{0.4323}) + (\underset{P/F,15,10}{0.2472}) + (\underset{P/F,15,15}{0.1229})]$

$x = \$46{,}911$

28. $P = \$800[\underset{P/A,8,14}{8.0890}][\underset{F/P,8,4}{1.377}] = \$8{,}911$

$F = \$5{,}974[\underset{F/P,8,5}{1.491}] = \$8{,}912$

29. $P = \$700(\underset{P/F,12,1}{0.8929}) + [\$700 + \$300(\underset{A/G,12,7}{2.5515})](\underset{P/A,12,7}{4.5638})(\underset{P/F,12,1}{0.8929}) = \$6{,}596$

30. $P = [\$10{,}000 + \$500(\underset{A/G,2,32}{13.8230})](\underset{P/A,2,32}{23.4683})(\underset{P/F,2,11}{0.8043}) = \$319{,}214$

31. $g' = [(1+0.10)/(1 - 0.15)] - 1 = 0.294$

$P = \$25(400{,}000)[(\underset{P/A,29.4,10}{3.14295})/(1-0.15)] = \$36{,}975{,}882$

32. (a) $g' = [(1+0.08)/(1+0.10)] - 1 = -0.0182$

$P = \$1.15(8{,}000)[(\underset{P/A,-1.82,5}{5.285})/(1+0.10)] = \$44{,}202$

(b) $A = \$44{,}202(\underset{A/P,8,5}{0.2505}) = \$11{,}073$

33. $\left(\$1{,}600 + G[\underset{A/G,10,15}{5.2001}]\right)[\underset{P/A,10,15}{7.3867}] = \$2{,}200[\underset{P/A,10,20}{8.222}]; \quad G = \$163$

34. $g' = [(1.10)/(1.06)] - 1 = 0.3774$

$\$5{,}000(\underset{F/P,8,10}{2.159})(\underset{F/P,3,20}{1.806}) = \$1{,}500(\underset{P/A,3.774,n}{\quad})/(1.06)$

Withdrawals of the full amount for 19 years with a partial withdrawal for the 20th year.

35. (a) $\$45{,}000(\underset{P/A,9,5}{3.8897})(\underset{P/F,9,2}{0.8417}) = \$147{,}328$

(b) $\$45{,}000(\underset{P/A,20,5}{2.9906})(\underset{P/F,20,2}{0.6945}) = \$93{,}464$

$\$147{,}328 - \$93{,}464 = \$53{,}864$

36. $g' = [(1.0175)/(1.005)] - 1 = 0.01244$ per month

P/A,1.244,60 A/P,23.14,5
[$2,000(42.1014)/(1.005)](0.3578) = $29,978 per year

37. P/A,g',6
$14,780 = $4,000( )/(1-0.10); g' = 20%
i = (1.20)(0.90) - 1 = 0.08

38. Monthly payments to the contractor

P/A,1,12 A/F,1,5
= $1,400(11.2551)(0.1960) = $3,088

39. $g'_1 = (1.15)/(1.08) - 1 = 0.06481$; $g'_2 = (1.05)/(1.08) - 1 = -0.02778$

P/A,6.481,7
P = $5,000(5.4882)/(1.08)

F/P,8,7 P/A,-2.778,13 P/F,15,7
+ [$5,000(1.714)(15.9222)/(1.08)](0.3759) = $72,902

40. P/A,15,5 P/F,15,3
(a) Payment = $15,000 (3.3522)(0.6575) = $33,061 (electrical company)

P/A,12,5 P/F,12,3
(b) Payment = $15,000(3.6048)(0.7118) = $38,488 (manufacturing company)

41. P/A,i,2 P/F,i,3
$3,500 = $1,500( ) + $2,000( ); i = 19.1%

42. P/A,i,48
$15,000 = $395( ); i = 1% per month; r = 12% compounded monthly

43. P/A,i,2
2.5 = 1 + 1( ); i = 21.6%

44. P/A,i,60
(0.98)$10,000 = $233.33( ); i = 1.25% per month
r = (12)(1.25%) = 15% compounded monthly
$i_a = (1.0125)^{12} - 1 = 0.1608$

45. Loan (P)=Price + sale taxes + title & registration -down payment

A/P,0.16,36
$A = [\$28,300 + \$2,123 + \$105 - \$10,000](0.0286) = \$587 / \text{month}$

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46. Pension Funds: $\$2{,}400(337.8824)_{F/A,9,40} = \$810{,}918$ at the end of the 40th year

Withdrawn Payments: $\$810{,}918(0.1018)_{A/P,9,25} = \$82{,}557$ per year

Deposits: (40)($2,400) = $96,000 Withdrawn: (25)($82,557)=$2,063,913

47. g' = [(1+0.08)/(1+0.05)]-1 = 0.0286 = 2.86%

$F = \$42{,}000(0.15)[(19.9674)_{P/A,0.0286,30}/(1+0.05)][(10.0627)_{F/P,8,30}] = \$1{,}205{,}550$

48. (a) g' = [(1+0.07)/(1+0.02)] - 1 = 0.049 = 4.9%

$\$1{,}000{,}000 = \$X[(14.2335)_{P/A,4.9,25}/(1+0.02)](5.4274)_{F/P,7,25}$; X = $13,204

(b) g' = [(1+0.07)/(1+0.02)] - 1 1 = 0.049 = 4.9%

$\$1{,}000{,}000 = \$X[(16.5788)_{P/A,4.9,35}/(1+0.02)](10.6766)_{F/P,7,35}$; X = $5,763

49. $A(488.258)_{F/A,2,120} = \$60{,}000(9.6506)_{P/A,8.24,20}$; A = $1,186 per quarter

50. $\$16{,}000(3.3872)_{P/A,7,4} = A(22.550)_{F/A,7,14}$; A = $2,403 annually

51. $P = \$10{,}000(0.07)(8.5136)_{P/A,10,20} + \$10{,}000(0.1487)_{P/F,10,20} = \$7{,}447$

52. $P = \$350(14.4955)_{P/A,4.5,24} + \$5{,}000(0.3477)_{P/F,4.5,24} = \$6{,}812$

53. Invest in bond:

$F = \$1{,}200(4.506)_{F/A,8,4}(1.611)_{F/P,10,5} + \$1{,}200(6.105)_{F/A,10,5} + \$10{,}000 = \$26{,}036$

Invest in bank:

$F = \$11{,}000(1.360)_{F/P,8,4}(1.611)_{F/P,10,5} = \$24{,}100$

54. $\$1{,}120 = \$110(\quad)_{P/A,i,10} + \$1{,}000(\quad)_{P,F,i,10}$; i = 9.12%

current yield = $110/$1,120 = 9.82%

55. $\$900 = \$80(P/A,i,5) + \$1{,}000(P/F,i,5)$; i = 10.68%

current yield = \$80/\$900 = 8.89%

56. $\$870 = \$30(P/A,i,20) + \$1{,}000(P/F,i,20)$

i = 3.95% per six months

effective rate per year = $(1.0395)^2 - 1 = 0.081$

current yield = \$60/\$870 = 6.90%

57. $\$12{,}000 = \$1{,}000(P/A,i,20) + \$10{,}000(P/F,i,20)$

i = 7.97% per year

current yield = \$1,000/\$12,000 = 8.33%

58. (a) $P = \$250(P/A,6,3) = \$250(2.6730) = \$668.25$

(b)

Year end	0	1	2	3
Amount deposited	\$668.25	\$668.25	\$458.35	\$235.85
Interest earned	0	40.10	27.50	14.15
Disbursement	0	- 250.00	- 250.00	- 250.00
Account balance	\$668.25	\$458.35	\$235.85	0

59. The payment $= \$5{,}000(A/P,1.25,30)(P/A,1.25,5) = \$5{,}000(0.0402)(4.8177) = \$968$

60. (a) $\$100{,}000 = A(P/A,7,5)$; A = \$24,389

(b)

Year end	0	1	2	3	4	5
Amount deposited	\$100,000	\$100,000	\$82,611	\$64,004.80	\$44,095.80	\$22,793.50
Interest earned	0	7,000	5,782.80	4,480.00	3,086.70	1,595.50
Withdrawal made	0	- 24,389	- 24,389	- 24,389	- 24,389	- 24,389
Account balance	\$100,000	\$82,611	64,004.80	44,095.80	22,793.50	0

61. (a) $\$10{,}000 = A(\underset{P/A,15,4}{2.855})$; A = $3,502.63

(b)

Year end	0	1	2	3	4
Amount owed	- $10,000	- $10,000	- $7,997.37	- $5,694.35	- $3,045.87
Interest owed	0	- 1,500.00	- 1,199.61	- 854.15	- 456.76
Payment made	0	3,502.63	3,502.63	3,502.63	3,502.63
Unpaid balance	- 10,000	- 7,997.37	- 5,694.35	- 3,045.87	0

62. $\$100{,}000(\underset{A/P,1,300}{0.01053}) = \$1{,}053$ per month

Solve by finding equivalent of payments paid

(a) $\$100{,}000(\underset{F/P,1,1}{1.010}) - \$1{,}053(\underset{F/A,1,1}{1.000}) = \$99{,}947$

$I_1 = \$1{,}053[1 - (\underset{P/F,1,300}{0.0505})] = \$1{,}000$

(b) $\$100{,}000(\underset{F/P,1,5}{1.0510}) - \$1{,}053(\underset{F/A,1,5}{5.1010}) = \$99{,}729$

$I_5 = \$1{,}053[1 - (\underset{P/F,1,296}{0.0526})] = \$997.84$

(c) $\$100{,}000(\underset{F/P,1,10}{1.1046}) - \$1{,}053(\underset{F/A,1,10}{10.4622}) = \$99{,}443$

$I_{10} = \$1{,}053[1 - (\underset{P/F,1,291}{0.0553})] = \$995.01$

(d) $\$100{,}000(\underset{F/P,1,15}{1.1610}) - \$1{,}053(\underset{F/A,1,15}{16.0969}) = \$99{,}143$

$I_{15} = \$1{,}053[1 - (\underset{P/F,1,286}{0.0581})] = \$992.04$

(e) $\$100{,}000(\underset{F/P,1,30}{1.3478}) - \$1{,}053(\underset{F/A,1,30}{34.7849}) = \$98{,}149$

$I_{30} = \$1{,}053[1 - (\underset{P/F,1,271}{0.0674})] = \$982.20$

(f) $\$100{,}000(\underset{F/P,1,45}{1.5648}) - \$1{,}053(\underset{F/A,1,45}{56.4811}) = \$96{,}994$

$I_{45} = \$1{,}053[1 - (\underset{P/F,1,256}{0.0783})] = \$970.76$

(g) $\$100{,}000(\underset{F/P,1,50}{1.6449}) - \$1{,}053(\underset{F/A,1,50}{64.4632}) = \$96{,}610$

$I_{50} = \$1{,}053[1 - (\underset{P/F,1,251}{0.0823})] = \$966.56$

62. Continued.

(h) $\$100{,}000(\underset{F/P,1,90}{2.4489}) - \$1{,}053(\underset{F/A,1,90}{144.8633}) = \$92{,}349$

$I_{90} = \$1{,}053[1 - (\underset{P/F,1,211}{0.1225})] = \$924.19$

(i) $\$100{,}000(\underset{F/P,1,100}{2.7048}) - \$1{,}053(\underset{F/A,1,100}{170.4814}) = \$90{,}963$

$I_{100} = \$1{,}053[1 - (\underset{P/F,1,201}{0.1353})] = \$910.69$

Solve by finding equivalent of future payments remaining

(j) $\underset{P/A,1,150}{\$1{,}053(77.5201)} = \$81{,}629$; $I_{150} = \$1{,}053[1 - (\underset{P/F,1,151}{0.2226})] = \$818.60$

(k) $\underset{P/A,1,50}{\$1{,}053(39.1961)} = \$41{,}273$; $I_{250} = \$1{,}053[1 - (\underset{P/F,1,51}{0.6020})] = \$419.16$

(l) $\underset{P/A,1,25}{\$1{,}053(22.0232)} = \$23{,}190$; $I_{275} = \$1{,}053[1 - (\underset{P/F,1,26}{0.7720})] = \$240.08$

63. $0.1956 = (1 + r/12)^{12} - 1$

r = 18% compounded monthly
i = 1.5% per month

$\$6{,}000(\underset{F/P,1.5,24}{1.430}) = \$264.72(\underset{F/A,1.5,24}{28.634}) + x$

$x = \$1{,}000$

64. $A = \$100{,}000(\underset{A/P,8,30}{0.0888}) = \$8{,}880$ per year

Amount owed after 12th year $= \$8{,}880(\underset{F/A,8,12}{18.977}) + \$8{,}880(\underset{F/A,8,4}{4.506}) - \$100{,}000(\underset{F/P,8,12}{2.518}) = -\$43{,}270$

65. (a) Equity $= \$90{,}000 - \$64{,}000[(\underset{A/P,1,360}{0.010286})(\underset{P/A,1,300}{94.9466})]$

$= \$90{,}000 - \$62{,}504 = \$27{,}496$

(b) Principal paid $= \$64{,}000 - \$62{,}504 = \$1{,}496$

Interest paid $= (60)\$64{,}000(\underset{A/P,1,360}{0.010286}) - \$1{,}496 = \$38{,}002$