capital of 16%, which projects should the company undertake?

Project ID	Projected ROR, % per year
Inventory	30
Technology	28.4
Warehouse	19
Products	13.1
Energy	9.6
Shipping	8.2

Spreadsheet Functions

1.42 State the purpose for each of the following built-in spreadsheet functions.
(*a*) PV(*i*%,*n*,*A*,*F*)
(*b*) FV(*i*%,*n*,*A*,*P*)
(*c*) RATE(*n*,*A*,*P*,*F*)
(*d*) IRR(first_cell:last_cell)
(*e*) PMT(*i*%,*n*,*P*,*F*)
(*f*) NPER(*i*%,*A*,*P*,*F*)

1.43 What are the values of the engineering economy symbols *P*, *F*, *A*, *i*, and *n* in the following functions? Use a question mark for the symbol that is to be determined.
(a) NPER(8%,−1500,8000,2000)
(*b*) FV(7%,102000,−9000)
(*c*) RATE(10,1000,−12000,2000)
(*d*) PMT(11%,20,,14000)
(*e*) PV(8%,15,−1000,800)

1.44 Write the engineering economy symbol that corresponds to each of the following spreadsheet functions.
(*a*) PMT (*b*) FV (*c*) NPER (*d*) PV (*e*) IRR

1.45 In a built-in spreadsheet function, if a certain parameter is not present, (*a*) under what circumstances can it be left blank and (*b*) when must a comma be entered in its place?

1.46 Sheryl and Marcelly both invest $1000 at 10% per year for 4 years. Sheryl receives simple interest and Marcelly gets compound interest. Use a spreadsheet and cell reference formats to develop relations that show a total of $64 more interest for Marcelly at the end of the 4 years. Assume no withdrawals or further deposits are made during the 4 years.

ADDITIONAL PROBLEMS AND FE EXAM REVIEW QUESTIONS

1.47 The concept that different sums of money at different points in time can be said to be equal to each other is known as:
(*a*) Evaluation criterion
(*b*) Equivalence
(*c*) Cash flow
(*d*) Intangible factors

1.48 The evaluation criterion that is usually used in an economic analysis is:
(*a*) Time to completion
(*b*) Technical feasibility
(*c*) Sustainability
(*d*) Financial units (dollars or other currency)

1.49 All of the following are examples of cash outflows, *except*:
(*a*) Asset salvage value
(*b*) Income taxes
(*c*) Operating cost of asset
(*d*) First cost of asset

1.50 In most engineering economy studies, the best alternative is the one that:
(*a*) Will last the longest time
(*b*) Is most politically correct
(*c*) Is easiest to implement
(*d*) Has the lowest cost

1.51 The following annual maintenance and operation (M&O) costs for a piece of equipment were collected over a 5-year period: $12,300, $8900, $9200, $11,000, and $12,100. The average is $10,700. In conducting a sensitivity analysis, the most reasonable range of costs to use (i.e., percent from the average) is:
(*a*) ±5% (*b*) ±11% (*c*) ±17% (*d*) ±25%

1.52 At an interest rate of 10% per year, the equivalent amount of $10,000 *one year ago* is closest to:
(*a*) $8264 (*b*) $9091 (*c*) $11,000 (*d*) $12,000

1.53 Assume that you and your best friend each have $1000 to invest. You invest your money in a fund that pays 10% per year *compound* interest. Your friend invests her money at a bank that pays 10% per year *simple* interest. At the end of 1 year, the difference in the total amount for each of you is:
(*a*) You have $10 more than she does
(*b*) You have $100 more than she does
(*c*) You both have the same amount of money
(*d*) She has $10 more than you do

1.54 The time it would take for a given sum of money to double at 4% per year *simple* interest is closest to:
(*a*) 30 years (*b*) 25 years
(*c*) 20 years (*d*) 10 years

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1.55 All of the following are examples of equity financing, *except*:
(*a*) Mortgage
(*b*) Money from savings
(*c*) Cash on hand
(*d*) Retained earnings

1.56 To finance a new project costing $30 million, a company borrowed $21 million at 16% per year interest and used retained earnings valued at 12% per year for the remainder of the investment. The company's weighted average cost of capital for the project was closest to:
(*a*) 12.5% (*b*) 13.6% (*c*) 14.8% (*d*) 15.6%

CASE STUDY

RENEWABLE ENERGY SOURCES FOR ELECTRICITY GENERATION

Background

Pedernales Electric Cooperative (PEC) is the largest member-owned electric co-op in the United States with over 232,000 meters in 12 Central Texas counties. PEC has a capacity of approximately 1300 MW (megawatts) of power, of which 277 MW, or about 21%, is from renewable sources. The latest addition is 60 MW of power from a wind farm in south Texas close to the city of Corpus Christi. A constant question is how much of PEC's generation capacity should be from renewable sources, especially given the environmental issues with coal-generated electricity and the rising costs of hydrocarbon fuels.

Wind and nuclear sources are the current consideration for the PEC leadership as Texas is increasing its generation by nuclear power and the state is the national leader in wind farm–produced electricity.

Consider yourself a member of the board of directors of PEC. You are an engineer who has been newly elected by the PEC membership to serve a 3-year term as a director-at-large. As such, you do not represent a specific district within the entire service area; all other directors do represent a specific district. You have many questions about the operations of PEC, plus you are interested in the economic and societal benefits of pursuing more renewable source generation capacity.

Information

Here are some data that you have obtained. The information is sketchy, as this point, and the numbers are very approximate. Electricity generation cost estimates are national in scope, not PEC-specific, and are provided in cents per kilowatt-hour (¢/kWh).

	Generation Cost, ¢/kWh	
Fuel Source	**Likely Range**	**Reasonable Average**
Coal	4 to 9	7.4
Natural gas	4 to 10.5	8.6
Wind	4.8 to 9.1	8.2
Solar	4.5 to 15.5	8.8

National average cost of electricity to residential customers: 11¢/kWh

PEC average cost to residential customers: 10.27 ¢/kWh (from primary sources) and 10.92 ¢/kWh (renewable sources)

Expected life of a generation facility: 20 to 40 years (it is likely closer to 20 than 40)

Time to construct a facility: 2 to 5 years

Capital cost to build a generation facility: $900 to $1500 per kW

You have also learned that the PEC staff uses the well-recognized *levelized energy cost* (LEC) method to determine the price of electricity that must be charged to customers to break even. The formula takes into account the capital cost of the generation facilities, the cost of capital of borrowed money, annual maintenance and operation (M&O) costs, and the expected life of the facility. The LEC formula, expressed in dollars per kWh for ($t = 1, 2, \ldots, n$), is

$$\text{LEC} = \frac{\sum_{t=1}^{t=n} \frac{P_t + A_t + C_t}{(1+i)^t}}{\sum_{t=1}^{t=n} \frac{E_t}{(1+i)^t}}$$

where P_t = capital investments made in year t
A_t = annual maintenance and operating (M&O) costs for year t
C_t = fuel costs for year t
E_t = amount of electricity generated in year t
n = expected life of facility
i = discount rate (cost of capital)

Case Study Exercises

1. If you wanted to know more about the new arrangement with the wind farm in south Texas for the additional 60 MW per year, what types of questions would you ask of a staff member in your first meeting with him or her?
2. Much of the current generation capacity of PEC facilities utilizes coal and natural gas as the primary fuel source. What about the ethical aspects of the government's allowance for these plants to continue polluting the atmosphere with the emissions that may cause health problems for citizens and further the effects of global warming? What types of regulations, if any, should be developed for PEC (and other generators) to follow in the future?

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Problems 13.45 through 13.48 are based on the following information.

Mid-Valley Industrial Extension Service, a state-sponsored agency, provides water quality sampling services to all business and industrial firms in a 10-county region. Just last month, the service purchased all necessary lab equipment for full in-house testing and analysis. Now an outsourcing agency has offered to take over this function on a per sample basis. Data and quotes for the two options have been collected. The MARR for government projects is 5% per year, and a study period of 8 years is chosen.

In-house: Equipment and supplies initially cost \$125,000 for a life of 8 years, an AOC of \$15,000, and annual salaries of \$175,000. Sample costs average \$25 each. There is no significant market value for the equipment and supplies currently owned.

Outsourced: Contractors quote sample cost averages of \$100 for the first 5 years, increasing to \$125 per sample for years 6 through 8.

13.45 Determine the breakeven number of tests between the two options.

13.46 Use a spreadsheet to graph the AW curves for both options for test loads between 0 and 4000 per year in increments of 1000 tests. What is the estimated breakeven quantity?

13.47 The service director has asked the outsource company to reduce the per sample costs by 25% across the board over the 8-year study period. What will this do to the breakeven point? (*Hint:* Look carefully at your graph from Problem 13.46 before answering.)

13.48 Assume the Extension Service can reduce its annual salaries from \$175,000 to \$100,000 per year and the per sample cost from \$25 to \$20. What will this do to the breakeven point? (*Hint:* Again, look carefully at your graph from the previous problem before answering.) What is the new annual breakeven test quantity?

ADDITIONAL PROBLEMS AND FE EXAM REVIEW QUESTIONS

13.49 In linear breakeven analysis, if a company expects to operate at a point *above* the breakeven point, it should select the alternative:
(*a*) With the lower fixed cost
(*b*) With the higher fixed cost
(*c*) With the lower variable cost
(*d*) With the higher variable cost

13.50 A company is considering two alternatives to automate the pH of process liquids. Alternative A will have fixed costs of \$42,000 per year and will require 2 workers at \$48 per day each. Together, these workers can generate 100 units of product per day. Alternative B will have fixed costs of \$56,000 per year, but with this alternative, 3 workers will generate 200 units of product. If x is the number of units per year, the variable cost (VC) in \$ per year for alternative B is represented by:
(*a*) $[2(48)/100]x$
(*b*) $[3(48)/200]x$
(*c*) $[3(48)/200]x + 56{,}000$
(*d*) $[2(48)/100]x + 42{,}000$

13.51 When the variable cost is reduced for linear total cost and revenue lines, the breakeven point decreases. This is an economic advantage because:
(*a*) The revenue per unit will increase.
(*b*) The two lines will now cross at zero.
(*c*) The profit will increase for the same revenue per unit.
(*d*) The total cost line becomes nonlinear.

13.52 $AW_1 = -23{,}000(A/P,10\%,10) + 4000(A/F,10\%,10) - 3000 - 3x$

$AW_2 = -8{,}000(A/P,10\%,4) - 2000 - 6x$

For these two AW relations, the breakeven point x, in miles per year, is closest to:
(*a*) 1130
(*b*) 1224
(*c*) 1590
(*d*) 655

13.53 To make an item in-house, equipment costing \$250,000 must be purchased. It will have a life of 4 years, an annual cost of \$80,000, and each unit will cost \$40 to manufacture. Buying the item externally will cost \$100 per unit. At $i = 15\%$ per year, it is cheaper to make the item in-house if the number per year needed is:
(*a*) Above 1047 units
(*b*) Above 2793 units
(*c*) Equal to 2793 units
(*d*) Below 2793 units

13.54 A procedure at Mercy Hospital has fixed costs of \$10,000 per year and variable costs of \$50 per test. If the procedure is automated, its fixed cost will be \$21,500 per year, but its variable cost will be only \$10 per test. The number of tests that must be performed each year for the two operations to break even is closest to:
(*a*) 290 (*b*) 455 (*c*) 750 (*d*) Over 800

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13.55 An assembly process can be completed using either alternative X or Y. Alternative X has fixed costs of $10,000 per year with a variable cost of $50 per unit. If the process is automated per alternative Y, its fixed cost will be $5000 per year and its variable cost will be only $10 per unit. The number of units that must be produced each year in order for alternative Y to be favored is closest to:

(*a*) Y will be favored for any level of production
(*b*) 125
(*c*) 375
(*d*) X will be favored for any level of production

13.56 Two different methods are under consideration for building a bypass road. Material C will cost $100,000 per mile and last for 10 years. Its annual maintenance cost will be $10,000 per year per mile. Material D will cost $30,000 per mile and last for 5 years. At an interest rate of 6% per year, the annual maintenance cost for material D that will make the two methods cost the same is closest to:

(*a*) Less than $14,000 (*b*) $14,270
(*c*) $16,470 (*d*) $19,510

13.57 A construction company can purchase a piece of equipment for $50,000 and spend $100 per day in operating costs. The equipment will have a 5-year life with no salvage value. Alternatively, the company can lease the equipment for $400 per day. The number of days per year the company must require the equipment to justify its purchase at an interest rate of 8% per year is closest to:

(*a*) 10 days (*b*) 42 days
(*c*) 51 days (*d*) 68 days

13.58 A tractor has a first cost of $40,000, a monthly operating cost of $1500, and a salvage value of $12,000 in 10 years. The MARR is 12% per year. An identical tractor can be rented for $3200 per month (operating cost not included). If n is the minimum number of months per year the tractor must be used in order to justify its purchase, the relation to find n is represented by:

(*a*) $-40{,}000(A/P,1\%,10) - 1500n + 12{,}000(A/F,1\%,10) = 3200n$
(*b*) $-40{,}000(A/P,12\%,10) - 1500n + 12{,}000(A/F,12\%,10) = 3200n$
(*c*) $-40{,}000(A/P,1\%,120) - 1500n + 12{,}000(A/F,1\%,120) = 3200n$
(*d*) $-40{,}000(A/P,11.4\%,10) - 1500n + 12{,}000(A/F,11.4\%,10) = 3200n$

13.59 An anticorrosive coating for a chemical storage tank will cost $5000 and last 5 years if touched up at the end of 3 years at a cost of $1000. If an oil-base enamel coating could be used that will last 2 years, the amount the enamel coating can cost for the two to breakeven at $i = 8\%$ per year is closest to:

(*a*) $2120 (*b*) $2390
(*c*) $2590 (*d*) $2725

13.60 The price of a car is $50,000 today. Its price is expected to increase by $2400 each year. You now have $25,000 in an investment that is earning 20% per year. The number of years before you have enough money to buy the car, without borrowing any money, is closest to:

(*a*) 3 years (*b*) 5 years
(*c*) 7 years (*d*) 9 years

13.61 Process A has a fixed cost of $16,000 per year and a variable cost of $40 per unit. For process B, 5 units can be produced in 1 day at a cost of $125. If the company's MARR is 10% per year, the fixed cost of process B that will make the two alternatives have the same annual cost at a production rate of 1000 units per year is closest to:

(*a*) Less than $10,000
(*b*) $18,000
(*c*) $27,000
(*d*) Over $30,000

13.62 The profit relation for the following estimates at a quantity that is 20% above breakeven is:

Fixed cost = $500,000 per year
Variable cost per unit = $200
Revenue per unit = $250

(*a*) Profit = 200(12,000) − 250(12,000) − 500,000
(*b*) Profit = 250(12,000) − 500,000 − 200 (12,000)
(*c*) Profit = 250(12,000) − 200(12,000) + 500,000
(*d*) Profit = 250(10,000) − 200(10,000) − 500,000

13.63 Two methods of weed control in an irrigation canal are under consideration. Method A involves lining at a cost of $4000. The lining will last 20 years. The maintenance cost with this method will be $3 per mile per year. Method B involves spraying a chemical that costs $40 per gallon. One gallon will treat 8 miles, but the treatment must be applied 4 times per year. In determining the number of miles per year that would result in breakeven, the variable cost for method B is closest to:

(*a*) $5 per mile (*b*) $15 per mile
(*c*) $20 per mile (*d*) $40 per mile

13.64 How long will you have to maintain a business that has an income of $5000 per year and expenses of $1500 per year if your initial investment was $28,000 and your MARR is 10% per year?

(*a*) Less than 6 years (*b*) 8 years
(*c*) 12 years (*d*) 17 years

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ADDITIONAL PROBLEMS AND FE EXAM REVIEW QUESTIONS

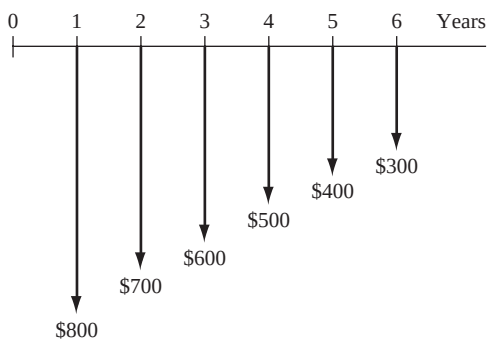
2.54 The amount of money that Diamond Systems can spend now for improving productivity in lieu of spending $30,000 three years from now at an interest rate of 12% per year is closest to:
(*a*) $15,700
(*b*) $17,800
(*c*) $19,300
(*d*) $21,350

2.55 A manufacturing company spent $30,000 on a new conveyor belt. If the conveyor belt resulted in cost savings of $4200 per year, the length of time it would take for the company to recover its investment at 8% per year is closest to:
(*a*) Less than 9 years
(*b*) 9 to 10 years
(*c*) 11 to 12 years
(*d*) Over 12 years

2.56 Levi Strauss has some of its jeans stone-washed under a contract with independent U.S. Garment Corp. If U.S. Garment's operating cost per machine is $22,000 for year 1 and increases by a constant $1000 per year through year 5, what is the equivalent uniform annual cost per machine for the 5 years at an interest rate of 8% per year?
(*a*) $23,850
(*b*) $24,650
(*c*) $25,930
(*d*) Over $26,000

2.57 The *F*/*G* factor values can be derived by multiplying:
(*a*) (*P*/*F*) and (*A*/*G*) factor values
(*b*) (*F*/*P*) and (*A*/*G*) factor values
(*c*) (*P*/*F*) and (*P*/*G*) factor values
(*d*) (*F*/*P*) and (*P*/*G*) factor values

2.58 At $i = 4\%$ per year, A for years 1 through 6 of the cash flows shown below is closest to:
(*a*) $300
(*b*) $560
(*c*) $800
(*d*) $1040



2.59 The value of the factor (*P*/*F*,*i*,10) can be found by getting the factor values for (*P*/*F*,*i*,4) and (*P*/*F*,*i*,6) and:
(*a*) Adding the values for (*P*/*F*,*i*,4) and (*P*/*F*,*i*,6)
(*b*) Multiplying the values for (*P*/*F*,*i*,4) and (*P*/*F*,*i*,6)
(*c*) Dividing the value for (*P*/*F*,*i*,6) by the value for (*P*/*F*,*i*,4)
(*d*) None of the above

2.60 A small construction company is considering the purchase of a used bulldozer for $61,000. If the company purchases the dozer now, the equivalent future amount in year 4 that the company is paying for the dozer at 4% per year interest is closest to:
(*a*) $52,143
(*b*) $65,461
(*c*) $71,365
(*d*) Over $72,000

2.61 The cost of lighting and maintaining the tallest smokestack in the United States (at a shuttered ASARCO refinery) is $90,000 per year. At an interest rate of 10% per year, the present worth of maintaining the smokestack for 10 years is closest to:
(*a*) $1,015,000
(*b*) $894,000
(*c*) $712,000
(*d*) $553,000

2.62 An enthusiastic new engineering graduate plans to start a consulting firm by borrowing $100,000 at 10% per year interest. The loan payment each year to pay off the loan in 7 years is closest to:
(*a*) $18,745
(*b*) $20,540
(*c*) $22,960
(*d*) $23,450

2.63 An engineer who believed in "save now and play later" wanted to retire in 20 years with $1.5 million. At 10% per year interest, to reach the $1.5 million goal, starting 1 year from now, the engineer must annually invest:
(*a*) $26,190
(*b*) $28,190
(*c*) $49,350
(*d*) $89,680

2.64 The cost of a border fence is $3 million per mile. If the life of such a fence is assumed to be 10 years, the equivalent annual cost of a

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10-mile-long fence at an interest rate of 10% per year is closest to:
(*a*) $3.6 million
(*b*) $4.2 million
(*c*) $4.9 million
(*d*) Over $5.0 million

2.65 An investment of $75,000 in equipment that will reduce the time for machining self-locking fasteners will save $20,000 per year. At an interest rate of 10% per year, the number of years required to recover the initial investment is closest to:
(*a*) 6 years
(*b*) 5 years
(*c*) 4 years
(*d*) 3 years

2.66 The number of years required for an account to accumulate $650,000 if Ralph deposits $50,000 each year and the account earns interest at a rate of 6% per year is closest to:
(*a*) 13 years
(*b*) 12 years
(*c*) 11 years
(*d*) 10 years

2.67 Aero Serve, Inc., manufactures cleaning nozzles for reverse-pulse jet dust collectors. The company spent $40,000 on a production control system that will increase profits by $13,400 per year for 5 years. The rate of return per year on the investment is closest to:
(*a*) 20%
(*b*) 18%
(*c*) 16%
(*d*) Less than 15%

2.68 Energy costs for a green chemical treatment have been increasing uniformly for 5 years. If the cost in year 1 was $26,000 and it increased by $2000 per year through year 5, the present worth of the costs at an interest rate of 10% per year is closest to:
(*a*) $102,900
(*b*) $112,300
(*c*) $122,100
(*d*) $195,800

2.69 In planning for your retirement, you expect to save $5000 in year 1, $6000 in year 2, and amounts increasing by $1000 each year through year 20. If your investments earn 10% per year, the amount you will have at the end of year 20 is closest to:
(*a*) $242,568
(*b*) $355,407
(*c*) $597,975
(*d*) $659,125

2.70 Income from a precious metals mining operation has been decreasing uniformly for 5 years. If income in year 1 was $300,000 and it decreased by $30,000 per year through year 4, the annual worth of the income at 10% per year is closest to:
(*a*) $310,500
(*b*) $258,600
(*c*) $203,900
(*d*) $164,800

2.71 If you are able to save $5000 in year 1, $5150 in year 2, and amounts increasing by 3% each year through year 20, the amount you will have at the end of year 20 at 10% per year interest is closest to:
(*a*) $60,810
(*b*) $102,250
(*c*) $351,500
(*d*) Over $410,000

CASE STUDY

TIME MARCHES ON; SO DOES THE INTEREST RATE

Background

During the last week, Sundara has read about different situations that involve money, interest rate, and different amounts of time. She has gotten interested in the major effects that time and interest rates have on the amount of money necessary to do things and the significant growth in the amount of money when a large number of years are considered. In all cases, the interest focuses on the amount of money at the end of the time period.

Information

The four situations are described here.

A. Manhattan Island was purchased in 1626 for $24. After 385 years in 2011, at 6% per year compounded interest, the current value must be very large.
B. At the age of 22, if she saved only $2000 per year for the next 10 years (starting next year) and made a return of 6% per year, by today's standards, she would have accumulated a nice sum at the age of 70.

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ADDITIONAL PROBLEMS AND FE EXAM REVIEW QUESTIONS

3.53 A manufacturer of toilet flush valves wants to have $1,900,000 available 3 years from now so that a new product line can be initiated. If the company plans to deposit money each year, starting *now*, the equation that represents the deposit each year at 8% per year interest is:

(*a*) 1,900,000(A/F,8%,3)
(*b*) 1,900,000(A/F,8%,4)
(*c*) 1,900,000 + 1,900,000(A/F,8%,3)
(*d*) 1,900,000 + 1,900,000(A/F,8%,2)

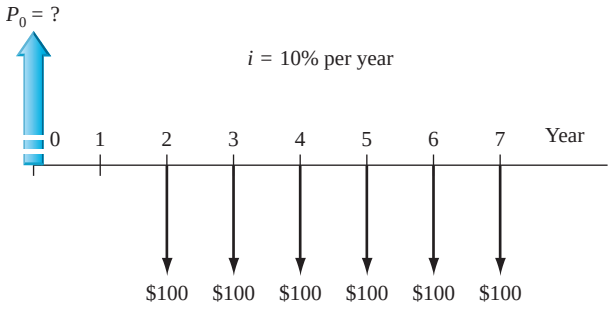
3.54 The present worth in year 0 of a lease that requires a payment of $9000 *now* and amounts increasing by 5% per year through year 10 at 8% per year interest is closest to:

(*a*) $73,652
(*b*) $79,939
(*c*) $86,335
(*d*) Over $87,000

3.55 For the diagram shown, the respective values of n for the following equation are:

$$P_0 = 100(P/A,10\%,n)(P/F,10\%,n)$$

(*a*) 6 and 1
(*b*) 6 and 2
(*c*) 7 and 1
(*d*) 7 and 2



3.56 Summit Metals is planning to expand its Wichita, Kansas, manufacturing operation 5 years from now at a cost of $10,000,000. If the company plans to deposit money into an account each year for 4 years beginning 2 years from now (first deposit is in year 2) to pay for the expansion, the equation that represents the amount of the deposit at 9% per year interest is:

(*a*) A = 10,000,000(A/F,9%,5)
(*b*) A = 10,000,000(A/F,9%,4)
(*c*) A = 10,000,000(A/P,9%,4)
(*d*) A = 10,000,000(A/F,9%,4)(P/F,9%,1)

3.57 The amount of money a person must deposit 3 years from now in order to withdraw $10,000 per year for 10 years beginning 15 years from now at an interest rate of 10% per year is closest to:

(*a*) $15,500 (*b*) $17,200
(*c*) $19,300 (*d*) $21,500

3.58 Cindy wants to deposit money for 4 consecutive years starting 3 years from now so she can withdraw $50,000 twelve years from now. Assume the interest rate is 8% per year. The annual deposit is closest to:

(*a*) $6990
(*b*) $7670
(*c*) $8530
(*d*) $10,490

3.59 The net present worth in year 0 of the following series of incomes and expenses at 8% per year is closest to:

Years	Income, $	Expenses, $
0	12,000	−1000
1–6	700	−100
7–11	900	−200

(*a*) $14,300 (*b*) $15,500
(*c*) $16,100 (*d*) $16,500

3.60 For the cash flows shown, the equivalent annual worth in periods 1 through 5 at an interest rate of 10% per year is closest to:

Annual Period	Amount, $
0	1000
1	1000
2	1000
3	1000
4	1000
5	1500

(*a*) $1120 (*b*) $1240
(*c*) $1350 (*d*) $1490

3.61 For the cash flows shown, the value of X that will make the present worth in year 0 equal to $5000 at an interest rate of 10% per year is closest to:

Year	0	1	2	3	4	5	6	7	8	9
Cash Flow, $	200	300	400	500	600	700	800	900	1000	X

(*a*) $2895 (*b*) $3125
(*c*) $3305 (*d*) $3765

3.62 In order to have cash available for unforeseen emergencies, Baring Systems, a military contractor, wants to have $2,000,000 in a contingency fund 4 years from now. The amount the company must deposit each year in years 0 through 4 at an interest rate of 10% per year is closest to:

(*a*) $420,100 (*b*) $327,600
(*c*) $284,600 (*d*) $206,900

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4.53 Periodic outlays for inventory control software at Baron Chemicals are expected to be $150,000 immediately, $200,000 in 1 year, and $350,000 in 2 years. What is the present worth of the costs at an interest rate of 10% per year, compounded continuously?

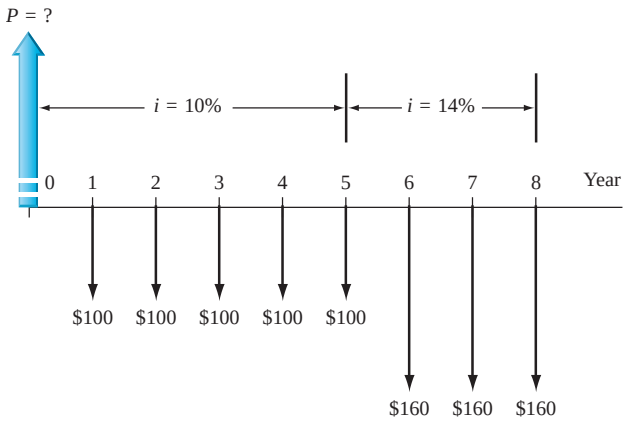
Varying Interest Rates

4.54 Many small companies use accounts receivable as collateral to borrow money for continuing operations and meeting payrolls. If a company borrows $300,000 now at an interest rate of 1% per month, but the rate changes to 1.25% per month after 4 months, how much will the company owe at the end of 1 year?

4.55 The maintenance cost for furnaces at a copper smelting plant have been constant at $140,000 per year for the past 5 years. If the interest rate was 8% per year for the first 3 years and then it increased to 10% in years 4 and 5, what is the equivalent future worth (in year 5) of the maintenance cost? Show hand and spreadsheet solutions.

4.56 By filling carbon nanotubes with miniscule wires made of iron and iron carbide, incredibly thin nanowires can be extruded by blasting the carbon nanotubes with an electron beam. If Gentech Technologies plans to spend $1.7 million in year 1, $2.1 million in year 2, and $3.4 million in year 3 to develop the technology, determine the present worth of the investments in year 0, if the interest rate in year 1 is 10% and in years 2 and 3 it is 12% per year.

4.57 Find (*a*) the present worth *P*, and (*b*) the equivalent uniform annual worth *A* for the cash flows shown below.



ADDITIONAL PROBLEMS AND FE EXAM REVIEW QUESTIONS

4.58 The term *annual percentage rate* is the same as:
(*a*) Effective rate
(*b*) Nominal rate
(*c*) Annual percentage yield
(*d*) All of the above

4.59 An interest rate is an effective rate under all of the following conditions, *except when:*
(*a*) The compounding period is not stated
(*b*) The interest period and compounding period are the same
(*c*) The interest statement says that the interest rate is effective
(*d*) The interest period is shorter than the compounding period

4.60 An interest rate of nominal 12% per year, compounded weekly, is:
(*a*) An effective rate per year
(*b*) An effective rate per week
(*c*) A nominal rate per year
(*d*) A nominal rate per week

4.61 An interest rate of 1.5% per month, compounded continuously, is the same as:
(*a*) An effective 1.5% per month
(*b*) 4.5% per quarter, compounded continuously
(*c*) 6.0% per quarter, compounded continuously
(*d*) 9% per 6 months

4.62 An effective 12.68% per year, compounded monthly, is the closest to:
(*a*) 12% per year
(*b*) 12% per year, compounded annually
(*c*) 1% per month
(*d*) 1% per month, compounded annually

4.63 For an interest rate of 2% per month, the effective *semiannual* interest rate is:
(*a*) 2.02%
(*b*) 12.005%
(*c*) 12.31%
(*d*) 12.62%

4.64 If you make quarterly deposits for 3 years into an account that compounds interest at 1% per month, the value of *n* in the *F*/*A* factor that will determine *F* at the end of the 3-year period is:
(*a*) 3
(*b*) 12
(*c*) 36
(*d*) None of these

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4.65 Identify the following interest rates as nominal or effective.

Rate 1: 1.5% per quarter
Rate 2: 1.5% per quarter, compounded monthly

(*a*) Both are nominal rates.
(*b*) Rate 1 is nominal and rate 2 is effective.
(*c*) Rate 1 is effective and rate 2 is nominal.
(*d*) Both are effective.

4.66 In solving uniform series problems, *n* in the standard factor notation equation is equal to the number of arrows (i.e., cash flows) in the original cash flow diagram when:

(*a*) The payment period (PP) is longer than the compounding period (CP).
(*b*) The compounding period is equal to the payment period.
(*c*) Both (*a*) and (*b*) are correct.
(*d*) The compounding period is longer than the payment period.

4.67 An engineer who is saving for her retirement plans to deposit $500 every *quarter*, starting one quarter from now, into an investment account. If the account pays interest at 6% per year, compounded semiannually, the total she will have at the end of 25 years is closest to:

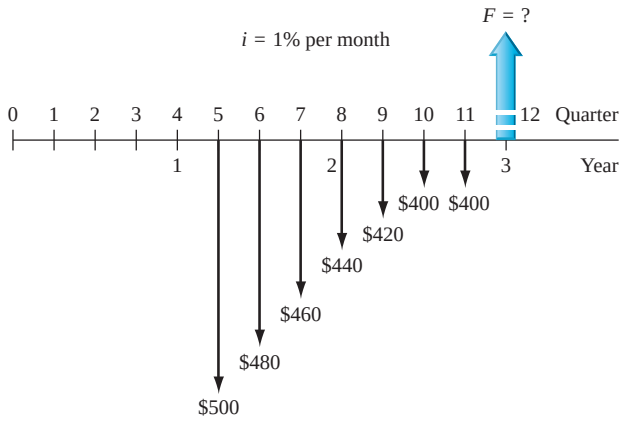
(*a*) $50,000 (*b*) $56,400
(*c*) $79,700 (*d*) $112,800

4.68 A company that makes flange-mount, motorized rotary potentiometers expects to spend $50,000 for a certain machine 4 years from now. At an interest rate of 12% per year, compounded quarterly, the present worth of the machine's cost is represented by the following equation:

(*a*) $P = 50{,}000(P/F, 3\%, 16)$
(*b*) $P = 50{,}000(P/F,$ effective i/6 months, 8)
(*c*) $P = 50{,}000(P/F,$ effective i/year, 4)
(*d*) Any of the above

4.69 For the cash flow diagram shown, the unit of the payment period (PP) is:

(*a*) Months (*b*) Quarters
(*c*) Semiannual (*d*) Years



4.70 A small company plans to spend $10,000 in year 2 and $10,000 in year 5. At an interest rate of *effective* 10% per year, compounded semiannually, the equation that represents the equivalent annual worth *A* in years 1 through 5 is:

(*a*) $A = 10{,}000(P/F,10\%,2)(A/P,10\%,5) + 10{,}000(A/F,10\%,5)$
(*b*) $A = 10{,}000(A/P,10\%,4) + 10{,}000(A/F,10\%,5)$
(*c*) $A = 10{,}000(P/F,5\%,2)(A/P,5\%,10) + 10{,}000(A/F,5\%,10)$
(*d*) $A = [10{,}000(F/P,10\%,5) + 10{,}000](A/F,10\%,5)$

4.71 Assume you make *monthly* deposits of $200 starting one month from now into an account that pays 6% per year, compounded semiannually. If you want to know the total after *4 years*, the value of *n* you should use in the F/A factor is:

(*a*) 2 (*b*) 4 (*c*) 8 (*d*) 12

4.72 The cost of replacing part of a cell phone videochip production line in 6 years is estimated to be $500,000. At an interest rate of 14% per year, compounded semiannually, the uniform amount that must be deposited into a sinking fund every 6 months is closest to:

(*a*) $21,335 (*b*) $24,825
(*c*) $27,950 (*d*) $97,995

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seawater (S) and purified groundwater (G). These costs were determined (Example 5.7) to be CC_S = \$−53.58 million and CC_G = \$−48.91 million. Groundwater is the clear economic choice.

Yesterday, the general manager had lunch with the president of Brissa Water, who offered to supply the needed UPW at a cost of \$5 million per year for the indefinite future. It would mean a dependence upon a contractor to supply the water, but the equipment, treatment, and other costly activities to obtain UPW on-site would be eliminated. The manager asks you to make a recommendation about this seemingly attractive alternative under the following conditions at the same MARR of 12% per year as used for the other analyses:

(*a*) The annual cost of \$5 million remains constant throughout the time it is needed.

(*b*) The annual cost starts at \$5 million for the first year only, and then it increases 2% per year. (This increase is above the cost of providing UPW by either of the other two methods.)

5.35 Compare the alternatives shown on the basis of their capitalized costs using an interest rate of 10% per year.

	Alternative M	Alternative N
First cost, \$	−150,000	−800,000
Annual operating cost, \$ per year	−50,000	−12,000
Salvage value, \$	8,000	1,000,000
Life, years	5	∞

5.36 The cost of maintaining a certain permanent monument in Washington, DC occurs as periodic outlays of \$1000 every year and \$5000 every 4 years. Calculate the capitalized cost of the maintenance using an interest rate of 10% per year.

5.37 Because you are thankful for what you learned in engineering economy, you plan to start a permanent scholarship fund in the name of the professor who taught the course. You plan to deposit money now with the stipulation that the scholarships be awarded beginning 12 years from now (which happens to be the exact time that your daughter plans to begin college). The interest that is accumulated between now and year 12 is to be added to the principal of the endowment. After that, the interest that is earned each year will be awarded as scholarship money. If you want the amount of the scholarships to be \$40,000 per year, how much must you donate now if the fund earns interest at a rate of 8% per year?

5.38 A patriotic group of firefighters is raising money to erect a permanent (i.e., infinite life) monument in New York City to honor those killed in the line of duty. The initial cost of the monument will be \$150,000, and the annual maintenance will cost \$5000. There will be an additional one-time cost of \$20,000 in 2 years to add names of those who were missed initially. At an interest rate of 6% per year, how much money must they raise now in order to construct and maintain the monument forever?

ADDITIONAL PROBLEMS AND FE EXAM REVIEW QUESTIONS

5.39 One assumption inherent in the present worth method of analysis is that:

(*a*) The alternatives will be used only through the life of the *shortest-lived* alternative.

(*b*) The alternatives will be used only through the life of the *longest-lived* alternative.

(*c*) The cash flows of each alternative will change only by the inflation or deflation rate in succeeding life cycles.

(*d*) At least one of the alternatives will have a finite life.

5.40 When only one alternative can be selected from two or more, the alternatives are said to be:

(*a*) Mutually exclusive

(*b*) Independent alternatives

(*c*) Cost alternatives

(*d*) Revenue alternatives

5.41 For the mutually exclusive alternatives shown, the one(s) that should be selected are:

Alternative	PW, \$
A	−25,000
B	−12,000
C	10,000
D	15,000

(*a*) Only C

(*b*) Only A

(*c*) C and D

(*d*) Only D

5.42 The alternatives shown are to be compared on the basis of their present worth values. At an interest rate of 10% per year, the values of *n* that you should use in the uniform series factors to make a

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correct comparison by the present worth method are:

	Alternative A	Alternative B
First cost, $	−50,000	−90,000
Annual operating cost, $ per year	−10,000	−4000
Salvage value, $	13,000	15,000
Life, years	3	6

(*a*) $n = 3$ years for A and $n = 3$ years for B
(*b*) $n = 3$ years for A and $n = 6$ years for B
(*c*) $n = 6$ years for A and $n = 6$ years for B
(*d*) None of the above

5.43 The value of the *future worth* for alternative P at an interest rate of 8% per year is closest to:

	P	Q
First cost, $	−23,000	−30,000
Annual operating cost, $ per year	−4,000	−2,500
Salvage value, $	3,000	1,000
Life, years	3	6

(*a*) $FW_P = \$-88{,}036$
(*b*) $FW_P = \$-86{,}026$
(*c*) $FW_P = \$-81{,}274$
(*d*) $FW_P = \$-70{,}178$

5.44 The present worth of $50,000 now, $10,000 per year in years 1 through 15, and $20,000 per year in years 16 through infinity at 10% per year is closest to:
(*a*) Less than $−169,000
(*b*) $−169,580
(*c*) $−173,940
(*d*) $−195,730

5.45 A donor (you) wishes to start an endowment that will provide scholarship money of $40,000 per year beginning in year 5 and continuing indefinitely. If the university earns 10% per year on the endowment, the amount you must donate now is closest to:
(*a*) $−225,470
(*b*) $−248,360
(*c*) $−273,200
(*d*) $−293,820

Problems 5.46 through 5.48 are based on the following information.

	Alternative I	Alternative J
Initial cost, $	−150,000	−250,000
Annual income, $ per year	20,000	40,000
Annual expenses, $ per year	−9,000	−14,000
Salvage value, $	25,000	35,000
Life, years	3	6

The interest rate is 15% per year.

5.46 In comparing alternatives I and J by the present worth method, the value of n that must be used in $11{,}000(P/A,i,n)$ for alternative I is:
(*a*) 3
(*b*) 6
(*c*) 18
(*d*) 36

5.47 In comparing alternatives I and J by the present worth method, the equation that yields the present worth of alternative J is:
(*a*) $PW_J = -250{,}000 + 40{,}000(P/A,15\%,6) + 35{,}000(P/F,15\%,6)$
(*b*) $PW_J = -250{,}000 + 26{,}000(P/A,15\%,6) + 35{,}000(P/F,15\%,6)$
(*c*) $PW_J = -250{,}000 - 26{,}000(P/A,15\%,6) + 35{,}000(P/F,15\%,6)$
(*d*) $PW_J = -250{,}000 - 26{,}000(P/A,15\%,6) - 35{,}000(P/F,15\%,6)$

5.48 In comparing alternatives I and J by the present worth method, the equation that yields the present worth of alternative I is:
(*a*) $PW_I = -150{,}000 + 11{,}000(P/A,15\%,3) + 25{,}000(P/F,15\%,3)$
(*b*) $PW_I = -150{,}000 + 11{,}000(P/A,15\%,6) + 25{,}000(P/F,15\%,6)$
(*c*) $PW_I = -150{,}000 + 11{,}000(P/A,15\%,6) + 175{,}000(P/F,15\%,3) + 25{,}000(P/F,15\%,6)$
(*d*) $PW_I = -150{,}000 + 11{,}000(P/A,15\%,6) - 125{,}000(P/F,15\%,3) + 25{,}000(P/F,15\%,6)$

Problems 5.49 and 5.50 are based on the following information.

	Machine X	Machine Y
Initial cost, $	−80,000	−95,000
Annual operating cost, $ per year	−20,000	−15,000
Salvage value, $	10,000	30,000
Life, years	2	4

The interest rate is 10% per year.

5.49 The equation that will calculate the present worth of machine X is:
(*a*) $PW_X = -80{,}000 - 15{,}000(P/A,10\%,4) + 30{,}000(P/F,10\%,4)$
(*b*) $PW_X = -80{,}000 - 20{,}000(P/A,10\%,4) - 80{,}000(P/F,10\%,2) + 10{,}000(P/F,10\%,4)$
(*c*) $PW_X = -80{,}000 - 20{,}000(P/A,10\%,2) + 10{,}000(P/F,10\%,2)$
(*d*) $PW_X = -80{,}000 - 20{,}000(P/A,10\%,4) - 70{,}000(P/F,10\%,2) + 10{,}000(P/F,10\%,4)$

5.50 In comparing the machines on a present worth basis, the present worth of machine Y is closest to:
(*a*) $−112,320
(*b*) $−122,060
(*c*) $−163,040
(*d*) $−175,980

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5.51 The capitalized cost of $10,000 every 5 years *forever*, starting *now* at an interest rate of 10% per year, is closest to:
(*a*) $−13,520
(*b*) $−16,380
(*c*) $−26,380
(*d*) $−32,590

5.52 At an interest rate of 10% per year, the capitalized cost of $10,000 in year 0, $5000 per year in years 1 through 5, and $1000 per year thereafter forever is closest to:
(*a*) −$29,652
(*b*) −$35,163
(*c*) −$38,954
(*d*) −$43,221

CASE STUDY

COMPARING SOCIAL SECURITY BENEFITS

Background

When Sheryl graduated from Northeastern University in 2000 and went to work for BAE Systems, she did not pay much attention to the monthly payroll deduction for social security. It was a "necessary evil" that may be helpful in retirement years. However, this was so far in the future that she fully expected this government retirement benefit system to be broke and gone by the time she could reap any benefits from her years of contributions.

This year, Sheryl and Brad, another engineer at BAE, got married. Recently, they both received notices from the Social Security Administration of their potential retirement amounts, were they to retire and start social security benefits at preset ages. Since both of them hope to retire a few years early, they decided to pay closer attention to the predicted amount of retirement benefits and to do some analysis on the numbers.

Information

They found that their projected benefits are substantially the same, which makes sense since their salaries are very close to each other. Although the numbers were slightly different in their two mailings, the similar messages to Brad and Sheryl can be summarized as follows:

If you stop working and start receiving benefits . . .

At age 62, your payment would be about	$1400 per month
At you full retirement age (67 years), your payment would be about	$2000 per month
At age 70, your payment would be about	$2480 per month

These numbers represent a reduction of 30% for early retirement (age 62) and an increase of 24% for delayed retirement (age 70).

This couple also learned that it is possible for a spouse to take spousal benefits at the time that one of them is at full retirement age. In other words, if Sheryl starts her $2000 benefit at age 67, Brad can receive a benefit equal to 50% of hers. Then, when Brad reaches 70 years of age, he can discontinue spousal benefits and start his own. In the meantime, his benefits will have increased by 24%. Of course, this strategy could be switched with Brad taking his benefits and Sheryl receiving spousal benefits until age 70.

All these options led them to define four alternative plans.

A: Each takes early benefits at age 62 with a 30% reduction to $1400 per month.

B: Each takes full benefits at full retirement age of 67 and receives $2000 per month.

C: Each delays benefits until age 70 with a 24% increase to $2480 per month.

D: One person takes full benefits of $2000 per month at age 67, and the other person receives spousal benefits ($1000 per month at age 67) and switches to delayed benefits of $2480 at age 70.

They realize, of course, that the numbers will change over time, based on their respective salaries and number of years of contribution to the social security system by them and by their employers.

Case Study Exercises

Brad and Sheryl are the same age. Brad determined that most of their investments make an average of 6% per year. With this as the interest rate, the analysis for the four alternatives is possible. Sheryl and Brad plan to answer the following questions, but don't have time this week. Can you please help them? (Do the analysis for one person at a time, not the couple, and stop at the age of 85.)

1. How much in total (without the time value of money considered) will each plan A through D pay through age 85?
2. What is the future worth at 6% per year of each plan at age 85?
3. Plot the future worth values for all four plans on one spreadsheet graph.
4. Economically, what is the best combination of plans for Brad and Sheryl, assuming they both live to be 85 years old?
5. Develop at least one additional question that you think Sheryl and Brad may have. Answer the question.

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Cost Category	Cost in Year ($ millions) 1	2	3	4	5	6 on	10	18
Field study	0.5							
Design of system	2.1	1.2	0.5					
Software design		0.6	0.9					
Hardware purchases			5.1					
Beta testing		0.1	0.2					
Users manual development		0.1	0.1	0.2	0.2	0.06		
System implementation				1.3	0.7			
Field hardware			0.4	6.0	2.9			
Training trainers			0.3	2.5	2.5	0.7		
Software upgrades						0.6	3.0	3.7

6.32 The U.S. Army received two proposals for a turnkey design-build project for barracks for infantry unit soldiers in training. Proposal A involves an off-the-shelf "bare-bones" design and standard grade construction of walls, windows, doors, and other features. With this option, heating and cooling costs will be greater, maintenance costs will be higher, and replacement will be sooner than for proposal B. The initial cost for A will be $750,000. Heating and cooling costs will average $72,000 per year, with maintenance costs averaging $24,000 per year. Minor remodeling will be required in years 5, 10, and 15 at a cost of $150,000 each time in order to render the units usable for 20 years. They will have no salvage value.

Proposal B will include tailored design and construction costs of $1.1 million initially, with estimated heating and cooling costs of $36,000 per year and maintenance costs of $12,000 per year. There will be no salvage value at the end of the 20-year life. Which proposal should be accepted on the basis of an annual life-cycle cost analysis, if the interest rate is 6% per year?

6.33 A medium-size municipality plans to develop a software system to assist in project selection during the next 10 years. A life-cycle cost approach has been used to categorize costs into development, programming, operating, and support costs for each alternative. There are three alternatives under consideration, identified as M, N, and O. The costs are summarized below. Use an annual life-cycle cost approach to identify the best alternative at 8% per year.

Alternative	Component	Estimated Cost
M	Development	$250,000 now, $150,000 years 1–4
	Programming	$45,000 now, $35,000 years 1, 2
	Operation	$50,000 years 1–10
	Support	$30,000 years 1–5
N	Development	$10,000 now
	Programming	$45,000 year 0, $30,000 years 1–3
	Operation	$80,000 years 1–10
	Support	$40,000 years 1–10
O	Operation	$175,000 years 1–10

ADDITIONAL PROBLEMS AND FE EXAM REVIEW QUESTIONS

6.34 All of the following are fundamental assumptions for the annual worth method of analysis *except*:

(*a*) The alternatives will be needed for only *one* life cycle.
(*b*) The services provided are needed for at least the LCM of the lives of the alternatives.
(*c*) The selected alternative will be repeated for the succeeding life cycles in exactly the same manner as for the first life cycle.
(*d*) All cash flows will have the same estimated values in every life cycle.

6.35 When comparing five alternatives that have different lives by the AW method, you must:

(*a*) Find the AW of each over the life of the longest-lived alternative.
(*b*) Find the AW of each over the life of the shortest-lived alternative.
(*c*) Find the AW of each over the LCM of all of the alternatives.
(*d*) Find the AW of each alternative over its life without considering the life of the other alternatives.

6.36 The annual worth of an alternative can be calculated from the alternative's:

(*a*) Present worth by multiplying by (*A*/*P*,*i*,*n*)
(*b*) Future worth by multiplying by (*F*/*A*,*i*,*n*)
(*c*) Either (*a*) or (*b*)
(*d*) Neither (*a*) nor (*b*)

6.37 The alternatives shown are to be compared on the basis of annual worth. At an interest rate of 10% per year, the values of *n* that you could use in the (*A*/*P*,*i*,*n*) factors to make a correct comparison by the annual worth method are:

	A	B
First cost, $	−50,000	−90,000
Annual cost, $ per year	−10,000	−4,000
Salvage value, $	13,000	15,000
Life, years	3	6

(*a*) $n = 3$ years for A and 3 years for B
(*b*) $n = 3$ years for A and 6 years for B
(*c*) Either (*a*) or (*b*)
(*d*) Neither (*a*) nor (*b*)

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6.38 The alternatives shown are to be compared on the basis of a perpetual (i.e., forever) equivalent annual worth. At an interest rate of 10% per year, the equation that represents the perpetual AW of X1 is:

	X1	Y1
First cost, $	−50,000	−90,000
Annual cost, $ per year	−10,000	−4,000
Salvage value, $	13,000	15,000
Life, years	3	6

(*a*) $AW_{X1} = -50{,}000(0.10) - 10{,}000 + 13{,}000(0.10)$

(*b*) $AW_{X1} = -50{,}000(0.10) - 10{,}000 + 13{,}000(A/F,10\%,3)$

(*c*) $AW_{X1} = -50{,}000(0.10) - 10{,}000 - 37{,}000(P/F,10\%,3)(0.10) + 13{,}000(0.10)$

(*d*) $AW_{X1} = -50{,}000(A/P,10\%,3) - 10{,}000 + 13{,}000(A/F,10\%,3)$

6.39 To get the AW of a cash flow of $10,000 that occurs every 10 years forever, with the first one occurring 10 years from now, you should:

(*a*) Multiply $10,000 by (*A/P,i,*10).
(*b*) Multiply $10,000 by (*A/F,i,*10).
(*c*) Multiply $10,000 by *i*.
(*d*) Multiply $10,000 by (*A/F,i,n*) and then multiply by *i*.

Problems 6.40 through 6.43 refer to the following estimates.

The alternatives are mutually exclusive and the MARR is 6% per year.

	Vendor 1	Vendor 2	Vendor 3
First cost, $	−200,000	−550,000	−1,000,000
Annual cost, $ per year	−50,000	−20,000	−10,000
Revenue, $ per year	120,000	120,000	110,000
Salvage value, $	25,000	0	500,000
Life, years	10	15	∞

6.40 The annual worth of vendor 2 cash flow estimates is closest to:

(*a*) $−63,370
(*b*) $43,370
(*c*) $−43,370
(*d*) $63,370

6.41 Of the following three relations, the correct one or ones to calculate the annual worth of vendor 1 cash flow estimates is (*note*: all dollar values are in thousands):

Relation 1: $AW_1 = -200(A/P,6\%,10) + 70 + 25(A/F,6\%,10)$

Relation 2: $AW_1 = [-200 - 50(P/A,6\%,10) + 120(P/A,6\%,10) + 25(P/F,6\%,10)](A/P,6\%,10)$

Relation 3: $AW_1 = -200(F/P,6\%,10) + 25 + (-50 + 120)(A/P,6\%,10)$

(*a*) 1 and 3
(*b*) Only 1
(*c*) 1 and 2
(*d*) Only 3

6.42 The AW values for the alternatives are listed below. The vendor or vendors that should be recommended is:

$AW_1 = \$44{,}723$ $AW_2 = \$43{,}370$
$AW_3 = \$40{,}000$

(*a*) 1 and 2
(*b*) 3
(*c*) 2
(*d*) 1

6.43 The capital recovery amount for vendor 3 is:

(*a*) $40,000 per year
(*b*) $60,000 per year
(*c*) $43,370 per year
(*d*) $100,000 per year

6.44 If a revenue alternative has a negative AW value and it was correctly calculated, it means the following:

(*a*) The equivalent annual worth of revenues does not exceed that of the costs.
(*b*) The estimates are wrong somewhere.
(*c*) A minus or plus sign of a cash flow was entered incorrectly into the PMT spreadsheet function.
(*d*) The alternative should have a longer life so revenues will exceed costs.

6.45 Estimates for one of two process upgrades are as follows: first cost of $40,000, annual cost of $5000 per year, market value that decreases by $2000 per year to the salvage value of $20,000 after the expected life of 10 years. If a 4-year study period is used for AW analysis at 15% per year, the correct AW value is closest to:

(*a*) $−15,000
(*b*) $−11,900
(*c*) $−7600
(*d*) $−12,600

6.46 The perpetual annual worth of investing $50,000 now and $20,000 per year starting in year 16 and continuing forever at 12% per year is closest to:

(*a*) $−4200
(*b*) $−8650
(*c*) $−9655
(*d*) $−10,655

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6.47 All the following statements about the capital recovery amount for an alternative are false *except:*

(*a*) Annual revenue can be no more than this amount, if the alternative is selected.

(*b*) A monetary estimate of new capital funds required each year for the life of the alternative.

(*c*) An amount of revenue required to recover the first cost plus a stated return over the life of the alternative.

(*d*) Does not consider the salvage value, since it is returned at the end of the alternative's life.

CASE STUDY

THE CHANGING SCENE OF AN ANNUAL WORTH ANALYSIS

Background and Information

Harry, owner of an automobile battery distributorship in Atlanta, Georgia, performed an economic analysis 3 years ago when he decided to place surge protectors in-line for all his major pieces of testing equipment. The estimates used and the annual worth analysis at MARR = 15% are summarized below. Two different manufacturers' protectors were compared.

	PowrUp	Lloyd's
Cost and installation, $	−26,000	−36,000
Annual maintenance cost, $ per year	−800	−300
Salvage value, $	2,000	3,000
Equipment repair savings, $	25,000	35,000
Useful life, years	6	10

The spreadsheet in Figure 6–9 is the one Harry used to make the decision. Lloyd's was the clear choice due to its substantially larger AW value. The Lloyd's protectors were installed.

During a quick review this last year (year 3 of operation), it was obvious that the maintenance costs and repair savings have not followed (and will not follow) the estimates made 3 years ago. In fact, the maintenance contract cost (which includes quarterly inspection) is going from $300 to $1200 per year next year and will then increase 10% per year for the next 10 years. Also, the repair savings for the last 3 years were $35,000, $32,000, and $28,000, as best as Harry can determine. He believes savings will decrease by $2000 per year hereafter. Finally, these 3-year-old protectors are worth nothing on the market now, so the salvage in 7 years is zero, not $3000.

Case Study Exercises

1. Plot a graph of the newly estimated maintenance costs and repair savings projections, assuming the protectors last for 7 more years.
2. With these new estimates, what is the recalculated AW for the Lloyd's protectors? Use the old first cost and maintenance cost estimates for the first 3 years. If these estimates had been made 3 years ago, would Lloyd's still have been the economic choice?
3. How has the capital recovery amount changed for the Lloyd's protectors with these new estimates?

	A	B	C	D	E	F	G
1	MARR =	15%					
2							
3			PowrUp			Lloyd's	
4		Investment	Annual	Repair	Investment	Annual	Repair
5	Year	and salvage	maintenance	savings	and salvage	maintenance	savings
6	0	-26,000	0	0	-36,000	0	0
7	1	0	-800	25,000	0	-300	35,000
8	2	0	-800	25,000	0	-300	35,000
9	3	0	-800	25,000	0	-300	35,000
10	4	0	-800	25,000	0	-300	35,000
11	5	0	-800	25,000	0	-300	35,000
12	6	2,000	-800	25,000	0	-300	35,000
13	7				0	-300	35,000
14	8				0	-300	35,000
15	9				0	-300	35,000
16	10				3,000	-300	35,000
17	AW element	-6,642	-800	25,000	-7,025	-300	35,000
18	**Total AW**			**$ 17,558**			**$ 27,675**

Figure 6–9
Annual worth analysis of surge protector alternatives, case study.

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7.49 Best Buy issued collateral bonds *4 years ago* that have a face value of $20,000 each and a coupon rate of 8% per year, payable semiannually. If the bond maturity date is 20 years *from the date they were issued* and the interest rate in the marketplace is now 12% per year, compounded semiannually, what is the present worth (now) of one bond?

7.50 In 2011, El Paso Water Utilities (EPWU) issued bonds worth $9.125 million to improve the Van Buren dam in central El Paso and to finance three other drainage projects. The bonds were purchased by the Texas Water Development Board under the federal stimulus program wherein EPWU did not have to pay any dividend on the bonds. If the bond dividend rate would have been 4% per year, payable quarterly, with a bond maturity date 18 years after issuance, what is the present worth of the dividend savings to EPWU rate payers? Assume the market interest rate is 6% per year.

7.51 A recently issued industrial bond with a face value of $10,000 has a coupon rate of 8% per year, payable annually. The bond matures 20 years from now. Jeremy is interested in buying one bond. If he pays $10,000 for the bond and plans to hold it to maturity, what rate of return per year will he realize?

7.52 Due to a significant troop buildup at the local military base, a school district issued $10,000,000 in bonds to build new schools. The bond coupon rate is 6% per year, payable semiannually, with a maturity date of 20 years. If an investor is able to purchase one of the bonds that has a face value of $5000 for $4800, what rate of return per 6 months will the investor realize? Assume the bond is kept to maturity.

7.53 As the name implies, a zero-coupon bond pays no dividend, only the face value when it matures. If a zero coupon bond that has a face value of $10,000 and a maturity date of 15 years is for sale for $2000, what rate of return will the purchaser make, provided the bond is held to maturity?

7.54 To provide infrastructure in the outlying areas of Morgantown, West Virginia, the city council issued 30-year bonds with a face value of $25 million. The bond coupon rate was set at 5% per year, payable semiannually. Because the market interest rate increased immediately before the bonds were sold, the city received only $23.5 million from the bond sale. What was the semiannual interest rate when the bonds were sold?

7.55 An investor who purchased a $10,000 mortgage bond today paid only $6000 for it. The bond coupon rate is 8% per year, payable quarterly, and the maturity date is 18 years from the year of issuance. Because the bond is in default, it will pay no dividend for the next 2 years. If the bond dividend is in fact paid for the following 5 years (after the 2 years) and the investor then sells the bond for $7000, what rate of return will be realized (*a*) per quarter and (*b*) per year (nominal)?

7.56 Five years ago, GSI, an oil services company headquartered in Texas, issued $10 million worth of 12% 30-year bonds with the dividend payable quarterly. The bonds have a call date of this year if GSI decides to take advantage of it. The interest rate in the marketplace decreased enough that the company is considering calling the bonds since the coupon rate is relatively high. If the company buys the bonds back now for $11 million, determine the rate of return that the company will make (*a*) per quarter and (*b*) per year (nominal). (*Hint:* The "call" option means the following: By spending $11 million now, the company will not have to make the quarterly bond dividend payments or pay the face value of the bonds when they come due 25 years from now.)

7.57 Four years ago, Chevron issued $5 million worth of debenture bonds with a coupon rate of 10% per year, payable semiannually. Market interest rates dropped, and the company called the bonds (i.e., paid them off in advance) at a 10% premium on the face value. Therefore, it cost the corporation $5.5 million to retire the bonds. What semiannual rate of return did an investor make who purchased a $5000 bond 4 years ago and held it until it was called 4 years later?

ADDITIONAL PROBLEMS AND FE EXAM REVIEW QUESTIONS

7.58 All of the following mean the same as *rate of return* except:
(*a*) Internal rate of return
(*b*) Time for return of capital
(*c*) Interest rate
(*d*) Return on investment

7.59 The numerical value of i in a rate of return equation can range from:
(*a*) 0% to 100%
(*b*) 0 to ∞
(*c*) −100% to +100%
(*d*) −100% to ∞

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7.60 The internal rate of return on an investment refers to the interest rate earned on the:
(*a*) Initial investment
(*b*) Unrecovered balance of the investment
(*c*) Money recovered from an investment
(*d*) Income from an investment

7.61 A conventional (or simple) cash flow series is one wherein:
(*a*) The algebraic signs on the net cash flows change only once.
(*b*) The interest rate you get is a simple interest rate.
(*c*) The total of the net cash flows is equal to 0.
(*d*) The total of the cumulative cash flows is equal to 0.

7.62 According to Descartes' rule of signs, for a net cash flow sequence of $--++-+$, the number of possible i values is:
(*a*) 2
(*b*) 3
(*c*) 4
(*d*) 5

7.63 According to Norstrom's criterion, the one statement below that is correct is:
(*a*) The cumulative cash flow must start out positively.
(*b*) The cumulative cash flow must start out negatively.
(*c*) The cumulative cash flow must equal 0.
(*d*) The net cash flow must start out positively.

7.64 According to Descartes' rule *and* Norstrom's criterion, the number of positive i^* values for the following cash flow sequence is:

Year	1	2	3	4
Revenue, $	25,000	15,000	4,000	18,000
Cost, $	30,000	7,000	6,000	12,000

(*a*) 1
(*b*) 2
(*c*) 3
(*d*) 4

7.65 For the net cash flows and cumulative cash flows shown, the value of x is:

Year	1	2	3	4	5
NCF, $	+13,000	−29,000	−25,000	x	−8000
Cumulative NCF, $	+13,000	−16,000	−41,000	+9000	+1000

(*a*) $7000
(*b*) $16,000
(*c*) $36,000
(*d*) $50,000

7.66 A company that uses a minimum attractive rate of return of 10% per year is evaluating new processes to improve operational efficiency. The estimates associated with candidate processes are shown.

	Alternative I	Alternative J
First cost, $	−40,000	−50,000
Annual cost, $ per year	−15,000	−12,000
Salvage value, $	5,000	5,000
Life, years	3	6

The statement that is most correct is:
(*a*) The alternatives are revenue alternatives.
(*b*) The alternatives are cost alternatives.
(*c*) The alternatives are revenue alternatives and DN is an option.
(*d*) The alternatives are cost alternatives and DN is an option.

7.67 Scientific Instruments, Inc. uses a MARR of 8% per year. The company is evaluating a new process to reduce water effluents from its manufacturing processes. The estimate associated with the process follows. In evaluating the process on the basis of a rate of return analysis, the correct equation to use is:

	New Process
First cost, $	−40,000
NCF, $ per year	13,000
Salvage value, $	5,000
Life, years	3

(*a*) $0 = -40{,}000 + 13{,}000(P/A,i,3) + 5000(P/F,i,3)$
(*b*) $0 = -40{,}000(A/P,i,3) + 13{,}000 + 5000(A/F,i,3)$
(*c*) $0 = -40{,}000(F/P,i,3) + 13{,}000(F/A,i,3) + 5000$
(*d*) Any of the above

7.68 When one is using the modified ROR method to remove multiple ROR values, an additional estimate needed besides the cash flows and their timings is:
(*a*) The ROIC value
(*b*) External rate of return
(*c*) Investment rate
(*d*) Internal rate of return

7.69 For the following cash flows, the modified rate of return method uses a borrowing rate of 10%, and an investment rate is 12% per year. The correct computation for the present worth in year 0 is:

Year	1	2	3	4	5
NCF, $	−10,000	0	0	−19,000	+25,000

(*a*) $-10{,}000 - 19{,}000(P/F,12\%,4)$
(*b*) $-10{,}000 - 19{,}000(P/F,12\%,4) + 25{,}000(P/F,10\%,5)$

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(*c*) 25,000(P/F,10%,5)
(*d*) $-10{,}000 - 19{,}000(P/F,10\%,4)$

7.70 The return on invested capital (ROIC) method removes multiple ROR values from a cash flow sequence. If the future worth computation in year t is $F_t < 0$, the ROIC rate i'' is used. The interpretation of $F_t < 0$ most closely means:
(*a*) The net balance of project cash flows in year t is negative.
(*b*) The resulting external rate of return will be positive.
(*c*) The net balance of project cash flows is positive in year t.
(*d*) The sequence has nonremovable negative ROR values.

7.71 The meaning of *return on invested capital* for a corporation is best stated as:
(*a*) A rate-of-return measure that equates the internal and external ROR
(*b*) A measure of how effectively the corporation uses capital funds invested in it
(*c*) The value at which borrowing ROR and investing ROR are equal
(*d*) The external rate of return value is based on total capital invested

7.72 A corporate $10,000 bond has a coupon rate of 8% per year, payable semiannually. The bond matures 20 years from now. At an interest rate of 6% per year, compounded semiannually, the amount and frequency of the bond dividend payments are:
(*a*) $600 every 6 months
(*b*) $800 every 6 months
(*c*) $300 every 6 months
(*d*) $400 every 6 months

7.73 A $20,000 mortgage bond that is due in 1 year pays interest of $500 every 3 months. The bond's coupon rate is:
(*a*) 2.5% per year, payable quarterly
(*b*) 5% per year, payable quarterly
(*c*) 5% per year, payable semiannually
(*d*) 10% per year, payable quarterly

7.74 A $10,000 municipal bond due in 10 years pays interest of $400 every 6 months. If an investor purchases the bond now for $9000 and holds it to maturity, the rate of return received can be determined by the following equation:
(*a*) $0 = -9000 + 400(P/A,i,10) + 10{,}000(P/F,i,10)$
(*b*) $0 = -9000 + 400(P/A,i,20) + 10{,}000(P/F,i,20)$
(*c*) $0 = -10{,}000 + 400(P/A,i,20) + 10{,}000(P/F,i,20)$
(*d*) $0 = -9000 + 800(P/A,i,10) + 10{,}000(P/F,i,10)$

7.75 A debenture bond issued 3 years ago has a face value of $5000, a coupon rate of 4% per year, payable semiannually, and a maturity date of 20 years *from the date it was issued*. The bond is for sale now for $4500. If the interest rate in the marketplace is compounded quarterly, the value of n that must be used in the P/A factor to calculate the rate of return for the bond is:
(*a*) 34
(*b*) 40
(*c*) 68
(*d*) 80

CASE STUDY

DEVELOPING AND SELLING AN INNOVATIVE IDEA

Background

Three engineers who worked for Mitchell Engineering, a company specializing in public housing development, went to lunch together several times a week. Over time they decided to work on solar energy production ideas. After a lot of weekend time over several years, they had designed and developed a prototype of a low-cost, scalable solar energy plant for use in multifamily dwellings on the low end and medium-sized manufacturing facilities on the upper end. For residential applications, the collector could be mounted along side a TV dish and be programmed to track the sun. The generator and additional equipment are installed in a closet-sized area in an apartment or on a floor for multiple-apartment supply. The system serves as a supplement to the electricity provided by the local power company. After some 6 months of testing, it was agreed that the system was ready to market and reliably state that an electricity bill in high-rises could be reduced by approximately 40% per month. This was great news for low-income dwellers on government subsidy that are required to pay their own utility bills.

Information

With a hefty bank loan and $200,000 of their own capital, they were able to install demonstration sites in three cities in the sunbelt. Net cash flow after all expenses, loan repayment, and taxes for the first 4 years was acceptable; $55,000 at the

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ADDITIONAL PROBLEMS AND FE EXAM REVIEW QUESTIONS

8.38 When conducting a rate of return (ROR) analysis involving multiple mutually exclusive alternatives, the first step is to:
(*a*) Rank the alternatives according to decreasing initial investment cost
(*b*) Rank the alternatives according to increasing initial investment cost
(*c*) Calculate the present worth of each alternative using the MARR
(*d*) Find the LCM between all of the alternatives

8.39 In comparing mutually exclusive alternatives by the ROR method, you should:
(*a*) Find the ROR of each alternative and pick the one with the *highest* ROR
(*b*) Select the alternative whose *incremental* ROR is the highest
(*c*) Select the alternative with ROR $\geq$ MARR that has the lowest initial investment cost
(*d*) Select the alternative with the largest initial investment that has been incrementally justified

8.40 When comparing independent projects by the ROR method, you should:
(*a*) Find the ROR of each project and pick the ones with the highest ROR
(*b*) Select all projects that have an overall ROR $\geq$ MARR
(*c*) Select the project with an overall ROR $\geq$ MARR that involves the lowest initial investment cost
(*d*) Select the project with the largest initial investment that has been incrementally justified

8.41 Of the following scenarios, alternative Y requires a higher initial investment than alternative X, and the MARR is 20% per year. The only scenario that requires an incremental investment analysis to select an alternative is that:
(*a*) X has an overall ROR of 22% per year, and Y has an overall ROR of 24% per year
(*b*) X has an overall ROR of 19% per year, and Y has an overall ROR of 23% per year
(*c*) X has an overall ROR of 18% per year, and Y has an overall ROR of 19% per year
(*d*) X has an overall ROR of 28% per year, and Y has an overall ROR of 26% per year

8.42 Alternatives whose cash flows (excluding the salvage value) are all negative are called:
(*a*) Revenue alternatives
(*b*) Nonconventional alternatives
(*c*) Cost alternatives
(*d*) Independent alternatives

8.43 For these alternatives, the sum of the incremental cash flows is:

Year	A	B
0	−10,000	−14,000
1	+2,500	+4,000
2	+2,500	+4,000
3	+2,500	+4,000
4	+2,500	+4,000
5	+2,500	+4,000

(*a*) $2500
(*b*) $3500
(*c*) $6000
(*d*) $8000

8.44 Helical Systems, Inc. uses a minimum attractive rate of return of 8% per year, compounded annually. The company is evaluating two new processes for improving the efficiency of its manufacturing operation. The cash flow estimates associated with each process are shown below. A correct equation to use for an incremental rate of return analysis is:

	Process I	Process J
First cost, $	−40,000	−50,000
Annual cost, $ per year	−15,000	−12,000
Salvage value, $	5,000	6,000
Life, years	3	3

(*a*) $0 = -10{,}000 + 3000(P/A,\Delta i^*,3) + 1000(P/F,\Delta i^*,3)$
(*b*) $0 = -40{,}000(A/P,\Delta i^*,3) - 15{,}000 + 5000(A/F,\Delta i^*,3)$
(*c*) $0 = -50{,}000(A/P,\Delta i^*,3) - 12{,}000 + 6000(A/F,\Delta i^*,3)$
(*d*) $0 = -10{,}000 - 3000(P/A,\Delta i^*,3) + 1000(P/F,\Delta i^*,3)$

8.45 For the four independent projects shown, the one or ones to select using a MARR of 14% per year are:

Project	Rate of Return, % per Year
A	14
B	12
C	15
D	10

(*a*) Only C
(*b*) Only A and C
(*c*) Only A
(*d*) Can't tell; need to conduct incremental analysis

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Problems 8.46 through 8.48 are based on the following information.

Five alternatives are being evaluated by the incremental rate of return method.

Alternative	Initial Investment, $	Overall ROR versus DN, %	Incremental Rate of Return, % A	B	C	D	E
A	−25,000	9.6	—	27.3	9.4	35.3	25.0
B	−35,000	15.1		—	0	38.5	24.4
C	−40,000	13.4			—	46.5	27.3
D	−60,000	25.4				—	6.8
E	−75,000	20.2					—

8.46 If the projects are mutually exclusive and the minimum attractive rate of return is 14% per year, the best alternative is:
(*a*) B (*b*) C (*c*) D (*d*) E

8.47 If the projects are mutually exclusive and the MARR is 20% per year, the best alternative is:
(*a*) B
(*b*) C
(*c*) D
(*d*) E

8.48 If the projects are independent, instead of mutually exclusive, the one or ones to select at an MARR of 18% per year are:
(*a*) B and C
(*b*) B, D, and E
(*c*) D and E
(*d*) B, C, and E

CASE STUDY

ROR ANALYSIS WITH ESTIMATED LIVES THAT VARY

Background

Make-to-Specs is a software system under development by ABC Corporation. It will be able to translate digital versions of three-dimensional computer models, containing a wide variety of part shapes with machined and highly finished (ultra-smooth) surfaces. The product of the system is the numerically controlled (NC) machine code for the part's manufacturing. Additionally, Make-to-Specs will build the code for superfine finishing of surfaces with continuous control of the finishing machines.

Information

There are two alternative computers that can provide the server function for the software interfaces and shared database updates on the manufacturing floor while Make-to-Specs is operating in parallel mode. The server first cost and estimated contribution to annual net cash flow are summarized below.

	Server 1	Server 2
First cost, $	100,000	200,000
Net cash flow, $/year	35,000	50,000 year 1, plus 5000 per year for years 2, 3, and 4 (gradient) 70,000 maximum for years 5 on, even if the server is replaced
Life, years	3 or 4	5 or 8

The life estimates were developed by two different individuals: a design engineer and a manufacturing manager. They have asked that, at this stage of the project, all analyses be performed using both life estimates for each system.

Case Study Exercises

Use spreadsheet analysis to determine the following:

1. If the MARR = 12%, which server should be selected? Use the PW or AW method to make the selection.
2. Use incremental ROR analysis to decide between the servers at MARR = 12%.
3. Use any method of economic analysis to display on the spreadsheet the value of the incremental ROR between server 2 with a life estimate of 5 years and a life estimate of 8 years.

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Attribute	Comment
1. Truck versus hoe height	90% as important as trenching speed
2. Type of topsoil	Only 10% of most important attribute
3. Type of subsoil	30% as important as trenching speed
4. Hoe cycle time	Twice as important as type of subsoil
5. Hoe trenching speed	Most important attribute
6. Pipe laying speed	80% as important as hoe cycle time

10.47 John, who works at Swatch, has decided to use the weighted attribute method to compare three systems for manufacturing a watchband. The vice president and her assistant VP have evaluated each of three attributes in terms of importance to them, and John has placed an evaluation from 0 to 100 on each alternative for the three attributes. John's *ratings* for each alternative are as follows:

	Alternative		
Attribute	1	2	3
Economic return > MARR	50	70	100
High throughput	100	60	30
Low scrap rate	100	40	50

Use the *weights* below to evaluate the alternatives. Are the results the same for both persons' weights? Why?

Importance Score	VP	Assistant VP
Economic return > MARR	20	100
High throughput	80	80
Low scrap rate	100	20

10.48 The Athlete's Shop has evaluated two proposals for weight lifting and exercise equipment. A present worth analysis at $i = 15\%$ per year of estimated revenues and costs resulted in $PW_A = \$440{,}000$ and $PW_B = \$390{,}000$. In addition to this economic measure, three more attributes were independently assigned a relative importance score from 0 to 100 by the shop manager and the lead trainer.

	Importance Score	
Attribute	Manager	Trainer
Economics	80	80
Durability	35	80
Flexibility	30	100
Maintainability	20	50

Separately, you have used the four attributes to rate the two equipment proposals on a scale of 0 to 1.0 as shown in the following table. The economic attribute was rated using the PW values.

Attribute	Proposal A	Proposal B
Economics	1.00	0.90
Durability	0.35	1.00
Flexibility	1.00	0.90
Maintainability	0.25	1.00

Select the better proposal using each of the following methods.
(*a*) Present worth
(*b*) Weighted evaluations of the shop manager
(*c*) Weighted evaluations of the lead trainer

ADDITIONAL PROBLEMS AND FE EXAM REVIEW QUESTIONS

10.49 The term *opportunity cost* refers to:
(*a*) The first cost of an alternative that has been accepted for funding
(*b*) The total cost of an alternative that has been accepted for funding
(*c*) The rate of return or profit available on the next-best alternative that had to be forgone due to lack of capital funds
(*d*) The cost of an alternative that was not recognized as an alternative that actually represented a good opportunity

10.50 The cost of capital is established on the basis of:
(*a*) The cost of debt financing
(*b*) The weighted average of debt and equity financing
(*c*) The cost of equity financing
(*d*) The cost of debt financing plus the expected inflation rate

10.51 All of the following are examples of debt capital except:
(*a*) Retained earnings
(*b*) Long-term bonds
(*c*) Loan from a local bank
(*d*) Purchase of equipment using a credit card

10.52 All of the following are examples of equity capital except:
(*a*) Sale of preferred stock
(*b*) Long-term bonds
(*c*) Company cash on hand
(*d*) Use of retained earnings

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10.53 If a public utility expands its capacity to generate electricity by obtaining $41 million from retained earnings and $30 million from municipal bond sales, the utilities' debt-to-equity mix is closest to:
(*a*) 58% debt and 42% equity
(*b*) 73% debt and 27% equity
(*c*) 27% debt and 73% equity
(*d*) 42% debt and 58% equity

10.54 Gentech, Inc. financed a new product as follows: $5 million in stock sales at 13.7% per year, $2 million in retained earnings at 8.9% per year, and $3 million through convertible bonds at 7.8% per year. The company's WACC is closest to:
(*a*) 9% per year
(*b*) 10% per year
(*c*) 11% per year
(*d*) 12% per year

10.55 If the after-tax rate of return for a cash flow series is 11.2% and the corporate effective tax rate is 39%, the approximated before-tax rate of return is closest to:
(*a*) 6.8%
(*b*) 5.4%
(*c*) 18.4%
(*d*) 28.7%

10.56 Medzyme Pharmaceuticals has maintained a 50-50 D-E mix for capital investments. Equity capital has cost 11%; however, debt capital that historically cost 9% has now increased by 20% per year. If Medzyme does not want to exceed its historical weighted average cost of capital (WACC), and it is forced to go to a D-E mix of 75–25, the maximum acceptable cost of equity capital is closest to:
(*a*) 7.6%
(*b*) 9.2%
(*c*) 9.8%
(*d*) 10.9%

10.57 The importance values (0 to 100) for five attributes are shown below. The weight to assign to attribute 1 is:
(*a*) 0.16
(*b*) 0.20
(*c*) 0.22
(*d*) 0.25

Attribute	Importance Score
1	55
2	45
3	85
4	30
5	60

10.58 For eight attributes rank-ordered in terms of increasing importance, the weighting of the sixth attribute is closest to:
(*a*) 0.17
(*b*) 0.14
(*c*) 0.08
(*d*) 0.03

CASE STUDY

WHICH IS BETTER—DEBT OR EQUITY FINANCING?

Background

Pizza Hut Corporation has decided to enter the catering business in three states within its Southeastern U.S. Division, using the name Pizza Hut At-Your-Place. To deliver the meals and serving personnel, it is about to purchase 200 vans with custom interiors for a total of $1.5 million. Each van is expected to be used for 10 years and have a $1000 salvage value.

A feasibility study completed last year indicated that the At-Your-Place business venture could realize an estimated annual net cash flow of $300,000 before taxes in the three states. After-tax considerations would have to take into account the effective tax rate of 35% paid by Pizza Hut.

An engineer with Pizza Hut's Distribution Division has worked with the corporate finance office to determine how to best develop the $1.5 million capital needed for the purchase of vans. There are two viable financing plans.

Information

Plan A is debt financing for 50% of the capital ($750,000) with the 8% per year compound interest loan repaid over 10 years with uniform year-end payments. (A simplifying assumption that $75,000 of the principal is repaid with each annual payment can be made.)

Plan B is 100% equity capital raised from the sale of $15 per share common stock. The financial manager informed the engineer that stock is paying $0.50 per share in dividends and that this dividend rate has been increasing at an average of 5% each year. This dividend pattern is expected to continue, based on the current financial environment.

Case Study Exercises

1. What values of MARR should the engineer use to determine the better financing plan?

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cost will be incurred for personnel and equipment during the last year of operation. (*Hint:* Calculate AW values for all combinations of defender/challenger options.)

(*b*) What is the percentage change in the AW amount each year for the 5-year period? If the decision to retain the current sanitation system for all 5 years is made, what is the economic disadvantage in AW compared to that of the most economic retention period?

Replacement Value

11.43 In 2008, Amphenol Industrial purchased a new quality inspection system for $550,000. The estimated salvage value was $50,000 after 8 years. Currently the expected remaining life is 3 years with an AOC of $27,000 per year and an estimated salvage value of $30,000. The new president has recommended early replacement of the system with one that costs $400,000 and has a 5-year economic service life, a $45,000 salvage value, and an estimated AOC of $50,000 per year. If the MARR for the corporation is 12% per year, find the minimum trade-in value now necessary to make the president's replacement economically advantageous.

11.44 A CNC milling machine purchased by Proto Tool and Die 10 years ago for $75,000 can be used for 3 more years. Estimates are an annual operating cost of $63,000 and a salvage value of $25,000. A challenger will cost $130,000 with an economic life of 6 years and an operating cost of $32,000 per year. Its salvage value will be $45,000. On the basis of these estimates, what market value for the existing asset will render the challenger equally attractive? Use an interest rate of 12% per year.

11.45 Hydrochloric acid, which fumes at room temperatures, creates a very corrosive work environment, causing steel tools to rust and equipment to fail prematurely. A distillation system purchased 4 years ago for $80,000 can be used for only 2 more years, at which time it will be scrapped with no value. Its operating cost is $75,000 per year. A more corrosion-resistant challenger will cost $220,000 with an operating cost of $49,000 per year. It is expected to have a $30,000 salvage value after its 6-year ESL. At an interest rate of 10% per year, what minimum replacement value now for the present system will render the challenger attractive?

11.46 Engine oil purifier machines can effectively remove acid, pitch, particles, water, and gas from used oil. Purifier A was purchased 5 years ago for $90,000. Its operating cost is higher than expected, so if it is not replaced now, it will likely be used for only 3 more years. Its operating cost this year will be $140,000, increasing by $2000 per year through the end of its useful life, at which time it will be donated for its recyclable scrap value. A more efficient challenger, purifier B, will cost $150,000 with a $50,000 salvage value after its 8-year ESL. Its operating cost is expected to be $82,000 for year 1, increasing by $500 per year thereafter. What is the market value for A that will make the two purifiers equally attractive at an interest rate of 12% per year?

ADDITIONAL PROBLEMS AND FE EXAM REVIEW QUESTIONS

11.47 In conducting a replacement study, all of the following are correct viewpoints for the analyst except:
(*a*) Consultant's
(*b*) Owner's
(*c*) Outsider's
(*d*) Nonowner's

11.48 A sunk cost is the difference between:
(*a*) The first cost and the salvage value
(*b*) The market value and the salvage value
(*c*) The first cost and the market value
(*d*) The book value and the market value

11.49 A truck was purchased 3 years ago for $45,000 and can be sold today for $24,000. The operating costs are $9000 per year, and it is expected to last 4 more years with a $5000 salvage value. A new truck, which will perform that same service, can be purchased for $50,000, and it will have a life of 10 years with operating costs of $28,000 per year and a $10,000 salvage value. The value that should be used as *P* for the presently owned vehicle in a replacement study is:
(*a*) $45,000
(*b*) $5000
(*c*) $50,000
(*d*) $24,000

11.50 The economic service life of an asset with the PW and AW values on the next page is:
(*a*) 1 year
(*b*) 2 years
(*c*) 3 years
(*d*) 4 years

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Years *n*	Present Worth If Kept *n* Years, $	Annual Worth If Kept *n* Years, $/Year
1	−15,455	−17,000
2	−28,646	−16,286
3	−45,019	−18,102
4	−57,655	−18,188
5	−72,867	−19,222

11.51 In looking for ways to cut costs and increase profit (to make the company's stock go up), one of the company's industrial engineers (IEs) determined that the equivalent annual worth of an existing machine over its remaining useful life of 3 years will be $–70,000 per year. The IE also determined that a replacement with more advanced features will have an AW of $–80,000 per year if it is kept for 2 years or less, $–75,000 if it is kept between 3 and 4 years, and $–65,000 if it is kept for 5 to 10 years. If the engineer uses a 3-year study period and an interest rate of 15% per year, she should recommend that the existing machine be:

(*a*) Replaced now
(*b*) Replaced 1 year from now
(*c*) Replaced 2 years from now
(*d*) Not replaced

11.52 The equivalent annual worth of an existing machine at American Semiconductor is estimated to be $–70,000 per year over its remaining useful life of 3 years. It can be replaced now or later with a machine that will have an AW of $–90,000 per year if it is kept for 2 years or less, –$65,000 if it is kept between 3 and 5 years, and $–110,000 if it is kept for 6 to 8 years. The company wants an analysis of what it should do for a 3-year study period at an interest rate of 15% per year. The replacement must be made now or 3 years from now, according to the department supervisor. You should recommend that the existing machine be replaced:

(*a*) Now
(*b*) 1 year from now
(*c*) 2 years from now
(*d*) Can't tell; must find AW of different retention combinations for the two machines

11.53 The cost characteristics of a CO testing machine at Dytran Instruments are shown below. The cost of a new tester is $100,000. The equation for determining the AW of keeping the tester for 2 years is:

(*a*) $AW = -100{,}000(A/P,i,8) - [42{,}000(P/F,i,1) + 47{,}000(P/F,i,2)](A/P,i,8) + 40{,}000(A/F,i,8)$
(*b*) $AW = -100{,}000(A/P,i,2) - [42{,}000(P/F,i,1) + 47{,}000(P/F,i,2)](A/P,i,2) + 40{,}000(A/F,i,2)$
(*c*) $AW = -100{,}000(A/P,i,2) - 47{,}000 + 40{,}000(A/F,i,2)$
(*d*) $AW = -100{,}000(A/P,i,2) - 42{,}000 + 40{,}000(A/F,i,2)$

Machine Age, Years	M&O Costs, $ per Year	Salvage Value at End of Year, $
1	−42,000	60,000
2	−47,000	40,000
3	−49,000	31,000
4	−50,000	24,000
5	−52,000	15,000
6	−54,000	10,000
7	−63,000	10,000
8	−67,000	10,000

11.54 An engineer with Haliburton calculated the AW values shown for a presently owned machine by using estimates he obtained from the vendor and company records.

Retention Period, Years	AW Value, $ per Year
1	−92,000
2	−81,000
3	−87,000
4	−89,000
5	−95,000

A challenger has an economic service life of 7 years with an AW of $–86,000 per year. Assume that used machines like the one presently owned will always be available and that the MARR is 12% per year. If all future costs remain as estimated for the analysis, the company should purchase the challenger:

(*a*) Now
(*b*) After 2 years
(*c*) After 3 years
(*d*) Never

11.55 The annual worth values for a defender, which can be replaced with a similar used asset, and a challenger are estimated. The defender should be replaced:

(*a*) Now
(*b*) 1 year from now
(*c*) 2 years from now
(*d*) 3 years from now

Number of Years Retained	AW Value, $ per Year	
	Defender	Challenger
1	−14,000	−21,000
2	−13,700	−18,000
3	−16,900	−13,100
4	−17,000	−15,600
5	−18,000	−17,500

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