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Economic Decisions, Engineering Costs and Cost Estimating

1

Multiple Choice Questions

1. Which of the following statements is incorrect?
2. Constructing the relationships between the decision-making elements is frequently called model building.
3. In economic decision making, the model is usually mathematical
4. Both of the above are incorrect.
5. Neither of the above is incorrect.
6. Which of the following is a beginning-of-period cash flow?
7. Salvage
8. Operations and maintenance
9. Revenue
10. Rent
11. Which term refers to the consideration of a cost for an additional unit?
12. Fixed cost
13. Marginal cost
14. Average cost
15. Variable cost
16. Which estimation model is described as the decomposition of the estimate into individual components?
17. Power-sizing model
18. Per-unit model
19. Segmenting model
20. Cost indexes
21. In a cash flow diagram, when are cash flows assumed to occur?
22. At the beginning of each period
23. Between each period
24. At the end of each period
25. Either A or B, depending on the details of the problem
26. What is an opportunity cost?
27. The cost of engaging in an opportunity
28. The cost of a resource that provides profit
29. The lowest cost of a resource
30. The benefit that is lost when a resource is engaged in another activity
31. Which of the following is generally assumed in life-cycle costing?
32. That the later a design change is made, the higher the cost
33. That costs are highly variable throughout the life of a project
34. That salvage values provide significant returns at the end of a project's life
35. That life-cycle costs are only useful once a product has been produced
36. As engineering economists we deal with present and future opportunities. Which of the following is true?
37. Sunk costs should be disregarded in our engineering economic analysis.
38. Only fixed and variable costs should be considered in our analysis.
39. We should consider all cost involved in the project except sunk and opportunity costs.
40. None of the above
41. What are the main phases of a typical life cycle for products, goods, and services?
42. Conceptual or Preliminary Design Phase, Production or Construction Phase
43. Needs Assessment and Justification Phase, Detailed Design Phase, Operational Use Phase and Decline and Retirement Phase
44. Needs Definition, Conceptual Design, Detailed Design, Production, Operational Use, and Decline/Retirement
45. None of the above
46. Engineering economists usually use which three general types of estimates?
47. Incremental estimates, opportunity estimates, and recurring estimates
48. Rough estimates, budget estimates, detailed estimates
49. Fixed estimates, variable estimates, and marginal estimates
50. One-of-a-kind estimates, time and effort estimates, and analogy estimates
51. What is engineering economic analysis helpful in approaching?
52. Decisions of intermediate difficulty and highly complex economic problems.
53. Simple problems only.
54. Highly complex problems only.
55. Intermediate problems only.
56. What are the first two steps in decision-making?
57. Recognizing the problem and defining the goal
58. Recognizing the problem and gathering data
59. defining the goal and gathering data
60. Recognizing the problem and identifying feasible alternatives
61. What is "overhead"?
62. The indirect costs of running a company that cannot be tied to any particular task that the company executes.
63. The cost of electricity.
64. The costs of constructing the rooves and ceilings for various buildings required for company operations.
65. Indirect costs associated with hiring (benefits, retirement, etc.)
66. Which of the following categories was not described by the text as a type of consequence of a decision?
67. Tangible consequence
68. Market consequence
69. Extra-market consequence
70. Intangible consequence
71. What is a feasible solution to a particular problem that is often ignored?
72. The "do-nothing" option
73. The "do-everything" option
74. The "win-at-all-costs" option
75. The "sacrifice-the-environment" option
76. In engineering economic analysis, what are the financial costs and benefits most easily represented by?
77. A cash-flow diagram
78. An Excel spreadsheet
79. A collection of receipts and invoices
80. None of the above
81. What is a common misconception?
82. If the "do-nothing" alternative is chosen, the current economic situation will not change.
83. The present value of a project is relevant to decision making.
84. That ethics is important in decision making.
85. That the environment is important in decision making.
86. The alternative solution "B" is "dominated" by another alternative solution "A" if:
87. all the outcomes of "A" are better than the outcomes that are predicted to follow from "B"
88. if one's boss says that regardless of the numbers "A" should be chosen.
89. if solution "A" is more forceful than solution "B"
90. if solution "B"s outcomes are all more favourable than the outcomes of solution "A".
91. The selection of which alternatives are viable options can be the crucial step if \_\_\_\_\_\_\_\_.
92. the rest of the analysis is rather mechanical .
93. the decision maker is rather simple-minded.
94. there is not enough data.
95. there are only 1 or 2 viable options.
96. What is a professional engineer most responsible for?
97. The public and the environment
98. Their client
99. Their profession
100. Their parents
101. What is Engineers Canada?
102. The federation of the provincial and territorial Professional Engineering associations.
103. The governing body of the provincial and territorial Professional Engineering associations.
104. Subject to the demands of the provincial and territorial Professional Engineering associations.
105. The entity that controls how each provincial and territorial Professional Engineering association runs its day-to-day operations.
106. What is the difficulty in making ethical decisions?
107. Sometimes who pays the cost and who gets the benefit of a decision are different entities/groups of people.
108. It is hard to determine how to choose between safety and cost.
109. Different cultures have different expectations around ethical behaviour.
110. All of the above

Essay/Short Answer Questions

1. Using the power-sizing model and given the following,  
   Battery A: rated at 15 Watt Hours for $100.00  
   Power sizing component: 0.4  
   What is the cost of battery B rated at 50 Watt Hours?
2. How much time does it take (in seconds) to assemble the 99th unit if:  
   Time to assemble unit #1 = 15 minutes  
   Learning curve rate = 60%
3. Consider the following information about an upcoming trip:  
   Travel 800 km per day  
   Car rental is $55.00 per day  
   Car insurance flat rate is $120.00  
   Travel insurance flat rate is $80 per person  
   Expected gas consumption cost is 0.20 per km  
   If there are 5 people going on the trip but the number of days has not been decided yet, what are the variable costs, the fixed costs, and the total costs?
4. What are two key concepts shown in life-cycle costing?
5. The cost index value for yearly power consumption 5 years ago was 233.  
   The cost index value for yearly power consumption today is 604.  
   If the yearly cost for power consumption 5 years ago was $9844.00, what is the yearly power consumption cost today?
6. A manufacturing plant that assembles television sets has a variable output volume from 200 sets to 350 sets per day. The building for both manufacturing and warehousing has an area of 80,000 square feet. It employs about 250 people. It purposes all of the components that go into the assembly.  
   a) What is an example for fixed cost in this plant is?  
   b) What is an example for variable in the plant cost?
7. What is marginal cost? Explain using an example.
8. Kal Tech Engineering Inc. manufactures video games for Play Station. Variable costs are estimated to be $20 per unit and fixed costs are $10,875. The demand-price relationship for this product is Q = 1,000 - (4 × P) where P is the unit sales price of the game and Q is the demand in number of units.  
   a) What is the break-even quantity (or quantities)?  
   b) What is the company's maximum possible revenue?  
   c) What profit would the company obtain by maximizing its total revenue?  
   d) What is the company's maximum possible profit?
9. An apparel manufacturing plant has estimated the variable cost to be $2.10 per unit. Fixed costs are $1 million per year. Forty per cent of its business is with one preferred customer and the customer is charged at cost. The remaining 60% of the business is with several different customers and each are charged $40 per unit.  
   Find:  
   a) The breakeven volume for this job shop  
   b) The unit cost if 100,000 units are made per year  
   c) The annual profit for this quantity
10. From the data below, estimate the cost of a wedding to be held in historical London, Ontario. Two hundred guests are being invited.  
    **Items** **Cost**Invitation $1,000  
    Rent for site $15,000  
    Wedding Gown $16,000  
    Brides Maid Dress $4000 for each (5 bridesmaids)  
    Flower Girl $500  
    Groom and Ushers, Tux. Rental $2000  
    Flowers $5000  
    Reception: Dinner $40,000  
     Cocktails/Soda $1.50 per glass or can  
     Mixed Drinks $5.00 per drink  
     Beer $4.00 per bottle or can  
    Miscellaneous $20,000  
    It is estimated that one-quarter of the guests will have one soda on average, one-half of the guests will have two mixed drinks on an average and the remaining guests will have two beers on an average.   
    Estimate the wedding cost and compute the cost per guest.
11. One hundred compressors of 200 H.P. rating are being considered for purchase by the state highway department. The compressor index was 400 five years ago, and is 520 today. The cost of 150 H.P. compressors bought five years ago is as follows. For the first 50 compressors, the cost was $2,000 per unit and for the second 50, the cost was $ 2400 per unit.   
    Find the cost of 100 compressors of 200 H.P rating today.
12. What is the difference between sunk costs and opportunity costs?
13. An entrepreneur is considering opening a coffee shop downtown. The building that he is considering will have a monthly lease payment of $3200 and basic utility costs of $600 per month. Two employees will be necessary to hire at $10.00/hour/employee (includes overhead and benefits). On average, each employee will work 170 hours per month. The average revenue per customer is estimated at $7.00. The variable cost of serving each customer is estimated at $2.00.   
    a) Calculate how many customers per month it will take for the coffee shop owner to break-even.  
    b) How many customers would need to be served per month to achieve a monthly profit of $5,000?
14. In engineering economics projects, the expenses and receipts usually fall into different categories. What are five of those categories?
15. Mike is considering buying a luxury car and is interested in computing the incremental costs of an imported car over a domestic car. The costs are as shown below.

Cost Imported Domestic

Purchase price 35,000 $31,000

Insurance / year 600 550

Fuel (Based on 24,000 km/year) 900 1000

Property tax 1250 1050

Maintenance 400 600

Salvage value after 5 years 15,000 6000

Ignoring the time value of money if Mike expects to have an incremental advantage of not less than $2000 on the imported car, should he buy the imported car?

1. A cocktail nut mix should have the following minimum requirements in a one-pound can, which is sold for $3.99 a can.  
   At least 10% almonds. Almonds cost $2.50 a pound.  
   A maximum of 50% peanuts. Peanuts cost $1.40 a pound.  
   At least 20% walnuts. Walnuts cost $2.25 a pound,  
   A maximum of 40% cashews. Cashews cost $2.00 a pound.  
   The can costs $0.10.  
   Find the proportion of these nuts by weight to maximize the profit. What is the profit that can be made per can if it is sold the retail store at $3.00 a can.
2. Identify the problems below that can be solved strictly from an economic perspective. What other factors need to be considered in addition to the economic perspective?  
   a) A money market account in a foreign bank pays 4% interest compared to a local bank.  
   b) An out-of-town-bank offers an interest rate of 12% on a credit card compared to a local bank that offers a credit at a 15% interest rate with a 1% cash bonus on all purchases.  
   c) Buying 12 tubes of toothpaste at a cost of $1.00 per tube on sale compared to paying $2.00 a tube every month as needed.
3. A high tech company in the US can have one of its popular items made offshore at half the price of making them in the US. However, about 90% of the items made offshore will be returned for refurbishing within the one-year warranty period. The following additional data is available:  
   Cost of making an item in the US = $250  
   Cost of refurbishing in the US = $50  
   Number Sold / Year = 500,000  
   Compute the cost savings that the company makes per year by making the item offshore.
4. Which of the following situations will require the use of economic analysis for making decisions?  
   a) Buying an automobile from a dealer with a manufacturer's interest rate of 0% or taking a loan for the automobile at the local credit union at an interest rate of 6% to take the rebate of $3000 from the dealer.  
   b) Adding another three-credit course when your load is only 12 credit hours and the university charges you for a 15 credit hour load regardless.  
   c) Buying a suit for $300 at a department store using a charge card. Assume that you normally pay off the charge card balance every month.  
   d) Refinancing a home mortgage from 7.5% to 6% if you know that you will be staying in the home at least for the next 5 years. Assume the loan is for $250K.
5. A motel had the following business on a particular week:  
   40 rooms at $60 a night for business (Sunday through Thursday) during weekdays  
   60 rooms at a weekly (5 days) rate of $200 per week. (Sunday through Thursday)  
   80 rooms at a discounted price of $40 per night for the entire week (7 days)  
   100 rooms for a family reunion at $50 per night for Friday and Saturday  
   If there are 200 rooms and the operating costs $20,000 plus a cleaning fee of $5 per room per day, compute the profit during the one-week period.
6. List five of the most possible criteria that could be used to judge the various alternatives.
7. To choose the best alternative usually the consequences of each alternative are stated in the form of costs and benefits. What are the categories of those consequences?
8. What do young engineers typically look for in a supervisor? What do more experienced engineers look for?
9. What are fixed costs? Can you give an example?
10. What are variable costs? Can you give an example?
11. What does "marginal cost" mean? Can you give an example?
12. What is the definition of the "break-even" point? What is the break-even point for a student society who is selling t-shirts to their classmates? The ordering cost from the t-shirt producer is $100 regardless of how many shirts are ordered. In addition, the producer asks to be paid $10 per t-shirt ordered. The society wants to sell them for $20 and has decided to take a risk and order 50 of the shirts. There are 75 students in the class and they are guessing at least 2/3rds of the class will buy one as that has been the percentage over the previous years.
13. What is a sunk cost? Can you think of an example? Why are these sorts of costs harmful to decision makers?
14. What is an opportunity or foregone opportunity cost?

Answer Key

Multiple Choice Questions

1. **b** (p. 10)
2. **d** (p. 32)
3. **b** (p. 17)
4. **c** (p. 25)
5. **c** (p. 31)
6. **d** (p. 20)
7. **a** (p. 22)
8. **a** (pp. 20-21)
9. **c** (pp. 22-23)
10. **b** (pp. 23-24)
11. **a** (p. 5)
12. **a** (p. 6)
13. **a** (p. 7)
14. **a** (p. 9)
15. **a** (p. 10)
16. **a** (p. 11)
17. **a** (p. 11)
18. **a** (p. 11)
19. **a** (p. 11)
20. **a** (p. 12)
21. **a** (p. 12)
22. **d** (p. 14)

Essay/Short Answer Questions

The answers to questions 1 to 20 are found in Chapter 1.

1. Cost of B = (50/15)0.4 × $100.00

= $161.86

1. b = log 0.60 / log 2.0 = -0.73697  
   T = (15)(60)(99)-0.73697

= 30 seconds

1. Fixed costs = (5)(80) + 120 = $520.00

Variable costs = 800(.20) + 55 = $215.00 per day

Total costs = $520.00 + $215.00(x)

(where x = number of days for trip)

1. 1. The later design changes are made, the higher the cost of the change.

2. Decisions made early in the life-cycle tend to "lock in" costs that are incurred later. (p. 22)

1. Yearly power consumption cost today = 604/233 × 9844 = $25518.35
2. a) Equipment cost. Equipment cost stays the same regardless of the level of output once the plant has been designed to produce at a certain level.  
   b) Labour cost. Labour cost depends on the output level.
3. Marginal cost is the cost of producing one additional unit. Often, this cost is used for making a decision about whether or not it is economical to produce another unit of the same item.  
   A good example for marginal cost is taking the fifth person in a taxicab that can take only four passengers. For the fifth person, a second cab has to be hired. The cab fare for the second cab is the marginal cost. (pp. 17-19)
4. Unit variable cost, Cv = $20.

Fixed cost, Cf = $10,875.

Since, Q = 1,000 - (4 × P), the unit selling price, P = 250 - (0.25 × Q)

Total Revenue, TR (Q) = P × Q = {250 - (0.25 × Q)} × Q = {(250 × Q) - (0.25 × Q2)}.

Total Cost, TC (Q) = 20 × Q + 10,875.

Profit, PI (Q) = TR (Q) - TC (Q) = [{(250 × Q) - (0.25 × Q2)} - {(20 × Q) + 10,875)}]

= -0.25 Q2 + 230 Q - 10,875.

Part (a): To find the breakeven quantities(s), set PI (Q) = 0.

(0.25 × Q2) + (230 × Q) - 10,875 = 0.

Solving this equation yields the breakeven quantities:

QBE1 = 50 units and QBE2 = 870 units.

Part (b): To find the maximum total revenue, set d(TR (Q))/dQ = 0 and solve for Q

(i.e.) 250- 0.5 Q = 0.

Q = 250 / 0.5 = 500 units.

The maximum total revenue is: TR (500) = (250 × 500) - (0.25 × 5002) = $62,500.

Part (c): The profit at the maximum revenue level is:

PI (500) = (0.25 × 5002) + (230 × 500) - 10,875 = $41,625.

Part (d): To find the maximum profit, set d(PI(Q))/dQ = 0.

-(0.5 × Q2 ) + 230 = 0.

Then solve for Q. Q = 230 / 0.5 = 460 units.

The maximum profit is: PI (460) = -(0.25 × 4602) + (230 × 460) - 10,875 = $42,025.

1. (a) Let X be the breakeven volume.

Total Cost / unit = (1,000,000 / X) + 21

Total Cost / year = {( 1,000,000 / X ) + 21 } \* X

Total Revenue per year = {(1,000,000 / X) + 21} \* (0.40 X) 40 \* 0.60 \* X

Equating the total cost per year to the total revenue generated, we get

1,000,000 + 21 X = 400,000 + 8.4 X + 24 X

(i.e.) 11.4 X = 600,000

X = 600,000/ 11.4 = 52,634 units

(b) Let C be the unit cost.

C = $(1,000,000/100,000) + 21 = $ 31

(c) Since profit is made only on 60% of the business, the annual profit may be computed as below.

Annual Profit = 0.60 (100,000) (40-31) = $540,000

1. This will be the summation of all the expenses.  
   Total = 1000 + 5000 + 16,000 + 20,000 + 4000 + 500 + 2000 + 5000 + 40,000 + {(0.25 × 200 × 1.50) + (0.5 × 200 × 5) +(0.25 × 100 × 4.00)}+ 20,000 = $124,175  
   Cost per guest = $124,175 /200 = $620.88
2. This problem requires the use of both the power sizing model and the cost index formula.  
   Average cost of 150 H.P, compressor 5 years ago = ($ 50 × 2000 + 50 × 2400)/100 = $2200  
   Cost of 150 H.P, Compressor today = $2200 × (520/400) = $2860  
   Cost of 200 H.P, Compressor / Cost of 150 H.P Compressor = (200/150)0.32  
   (Power sizing exponent 0.32 is read from table in the textbook.)  
   Cost of 200 H.P. Compressor = $2860 × (200/150)0.32 = $3136  
   Cost of 100 compressors of 200 H.P rating = $313,600
3. A sunk cost is the cost that has already been incurred. A classic example of sunk cost is the purchase of high-tech equipment. For example, equipment bought for $50,000 three years ago may be worth only $10,000 even though the book value may be $20,000. The $10,000 difference is sunk cost for the equipment.  
   An opportunity cost is the cost of having foregone the opportunity of getting better return. This happens when a decision is made to invest the available funds in another business activity. A good example for this is investing $5,000 in a money market account at a 2% interest rate rather than in a riskier venture with a 4% rate for two year. (pp. 19-21)
4. (a) At breakeven, TC = TR

TC = 3200 + 600 + 2(10)(170) + 2x

TR = 7x

Setting TC = TR

3200 + 600 + 2(10)(170) + 2x = 7x

7200 + 2x = 7x

7200 = 5x

X = 1440 customers/month

(b) TR - TC = 5000

7x - (3200 + 600 + 2(10)(170) + 2x) = 5000

7x - 7200 - 2x = 5000

5x = 12200

X = 2440 customers/month

1. 1. First cost,

2. Operations and maintenance,

3. Salvage value

4. Revenues

5. Overhaul (p. 32)

1. Incremental Cost (Imported - Domestic)

Purchase price = 35,000 - 31,000 = 4000

Insurance / year = 600 - 550 = 50

Fuel (Based on 24,000 km/year) = 900 - 1000 = -100

Property tax =1250 - 1050 = 250

Maintenance = 400-600 = -200

Salvage value after 5 years = -15,000- (-6000) = - 9000 **(Note that this is a gain.)**

Incremental advantage of the imported car = 9000 + 100 + 200 - (4000 - 50 - 250) = 5000  
Mike should definitely consider buying the imported car based on the assumption that the time value of money may be ignored.

1. 10% almond by weight = 0.10 × $2.50 = $0.25

50% peanut by weight = 0.50 × $1.40 = $0.70

The remaining 50% weight has to be filled by cashew and walnuts. Since cashews are cheaper than walnuts, let us use the maximum possible percentage of cashew nuts.

20% of cashews = 0.20 × $2.00 = $0.40

20% of walnuts = 0.20 × $2.25 = $0.45

Can = $0.10

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Total cost = $1.80

Profit per can = $3.00 - 1.80 = $1.20

1. a) The foreign bank's interest rate is definitely better. Other factors that need to be considered are fluctuations in exchange rate and the insurance requirements on the account and tax implications.  
   b) If you pay off the balance at the end of each month, the local bank's rate is attractive. One of the important factors to consider is whether or not you have the ability to pay off the balance.  
   c) Buying 12 tubes of paste at a sale price of $1 a tube makes a lot of sense. One of the important factors to consider is whether the paste will deteriorate over time.
2. Cost savings per item = $250 × 0.50 - 0.90 × 50 = $80  
   Cost savings per year = $500,000 × 80 = $4,000,000
3. a) This will require an economic analysis to make a decision.  
   b) This does not require any economic analysis. If you have the time and if you can handle the load, you should do it.  
   c) This does not require any analysis.  
   d) This will require an analysis.
4. Total number of rooms to be cleaned for the week = 40 × 5 + 80 × 5 + 80 × 7 + 100 × 2 = 1,360  
   Cleaning costs = $1,360 × 5 = $6800   
   Total costs for the entire week = Operating costs + Cleaning costs

= $6800 + $20,000 = $26,800

Revenue for the entire week = $60 × 40 × 5 + 200 × 60 + 40 × 80 + 50 × 2 × 100 = $37,200  
Profit for the whole week = 37,200 - 26,800 = $10,400

1. 1. Must create minimal disturbance to the environment.

2. Must improve the distribution of wealth among people.

3. Must minimize the expenditure of money.

4. Must ensure that the benefits to those who gain from the decision are greater than the losses of those who are harmed by the decision.

5. Must minimize the time needed to accomplish the goal or objective.

6. Must minimize unemployment.

7. Must maximize profit. (p. 10)

1. Market consequences  
   Extra-market consequences  
   Intangible consequences (p. 11)
2. Young engineers typically want a supervisor who will give them opportunities to hone their craft so they can grow in their skill set and become better at their job. As engineers become more experienced they tend to want a supervisor that shows great integrity and performs their job ethically. (p. 14)
3. These are costs that remain the same regardless of whether a company produces lot of goods and services or little. For example the property tax a company pays for the building it occupies each year will be the same regardless of what they produce or how much money they make. (p. 17)
4. Variable costs are those costs which do change depending on a particular variable. For example, "Costs of Good Sold" (COGS) will vary depending on how many of such goods a company makes for sale. Of course, if you make 200 units, your COGS will be twice as high than if you make 100 units of a product. (p. 17)
5. The marginal cost is the cost of producing or consuming one more unit of a given product. For example, at an all-you-can-eat sushi bar, the cost of an additional unit (one more sushi roll) is 0$ (assuming you don't have to pay for sushi you leave on the table). However, at a normal sushi restaurant the cost of one more roll will probably be in the range of $5-$10. (p. 17)
6. The break-even point is the number of units required to make revenues and expenses balance.   
   Fixed costs:$100  
   variable costs: $10  
   total variable costs: 10\*50 = 500  
   total costs = $600  
   break even = $600/$20 =30  
   After they sell 30 shirts they will be making a profit to put back into the student society. (p. 18)
7. A sunk cost is a cost that has already occurred and cannot be changed. Sunk costs should not be included in any economic analysis. These are harmful to decision makers as often people do consider sunken costs (that no matter what action is taken cannot be changed!) in their decision.   
   For example: Jane is wondering if she should buy a used car or keep her current vehicle. Last month she spent $400 in replacing the muffler but economic analysis suggests that, starting from today, given the approximate annual maintenance costs of a newer vehicle and the initial cost, it is still cheaper to buy the newer vehicle now. Jane may feel as though she should stick with her car as she just put money into it; however, whether she decides to keep the vehicle or not that $400 has been spent. The only thing that matters now is what is the best way to move forward to minimize her maintenance costs.(p. 19)
8. Often particular resources can only be used in one way. For example, one can either decide to repair or sell an ageing lathe; it would not make sense to repair it for use and then sell it (as normally you would not recover the cost of repairing it). So, if you decide to keep and continue to use an old lathe that you could sell for $10,000 today, it is as if that lathe is "costing" you $10,000 to keep. The cost of the missed opportunity to sell is $10,000. (p. 20)