

STUDY PROBLEMS #1

The principal purpose of the study problems is to assist you in understanding course concepts by applying them to specific problems. Simply getting the correct answer, without understanding how or why, is of little value. Therefore, you are strongly encouraged to work in groups of 2 or 3 on these problems, so that you can observe and discuss multiple ideas and approaches to solving the problems.

1. Problem 5, page 27 in the text.
2. Problem 12, page 28 in the text.
3. Problem 15, page 29 in the text.
4. Problem 1, page 55 in the text.
5. Problem 6, page 55 in the text.
6. Problem 1, page 315 in the text.
7. Problem 3, page 315 in the text.
8. Problem 4, page 315 in the text.
9. Identify at least two sets of circumstances under which an economic decision might be made without considering the time-value of money. In one case, justify a decision based on initial cost. In the second case, justify a decision based on lowest life-cycle cost (without adjusting for time value of money).
10. A new engineer is earning \$45,000 in her first year on the job. She decides to save for retirement by investing 5% of her annual salary in a tax-deferred fund, which she does every year during a 40-year career. Assume that her salary increases 6% per year and that the fund generates a return of 10% per year. What is the maximum amount she can withdraw from the fund in the first year of retirement, assuming that she plans to increase her future annual withdrawals by 4% per year, that the fund will earn 8% per year, and that she wants the fund to last for 25 years? HINT: Divide this problem into two parts, first calculating the value of the fund upon the transition from work to retirement.

Name: _____ Student #: _____

Problem 1. (18 points)

For each of the following economic computations, (a) list the conversion factor to be used, specifying the parameter values, and (b) compute the result, showing your work. Write your answers on the blank lines on the right edge of this page; correct answers in other locations may not receive full credit. An example is provided.

EXAMPLE:

If you invest \$100 in a bank account today, at an interest rate of 6.5%, how much will you have after five years?

- (a) (F/P, 6.5%, 5)
 (b) \$137.01

$$100 * (F/P, 6.5\%, 5) = 100 * (1 + 0.065)^5 = 100 * 1.3701 = 137.01$$

A. (4 points) How much would you need to invest annually, at an interest rate of 4%, in order to have \$12,000 after 10 years?

- (a) _____
 (b) _____

B. (4 points) A bond will be worth \$50,000 in 30 years. At a discount rate of 8%, how much would you pay for that bond today?

- (a) _____
 (b) _____

C. (5 points) A maintenance fund has been established that currently contains \$8500. Assuming the fund earns 7% annually, how much can be spent each year if the fund is to last for 12 years?

- (a) _____
 (b) _____

D. (5 points) The first-year operating costs for a machine are estimated to be \$5000 and are expected to increase 6% each year. What is the present value of the lifetime operating costs, assuming a useful life of 15 years and an interest rate of 10%?

- (a) _____
 (b) _____

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Problem 2. (10 points)

A. (8 points) Two machinery options are described below. Complete the table below, indicating the present value of each of the items specified. Assume an interest rate of 6% and a useful lifetime of 8 years. Show all of the necessary work to calculate the values. If you need more space, use the back of this sheet.

You may find the following conversion factors to be useful:

- (F/P, 6%, 8) = 1.5938 (P/F, 6%, 8) = 0.6274
 (A/F, 6%, 8) = 0.1010 (F/A, 6%, 8) = 9.8975
 (A/P, 6%, 8) = 0.1610 (P/A, 6%, 8) = 6.2098
 (P/G, 6%, 8) = 19.8416

OPTION 1: The initial purchase price of the machine is \$25,000. The salvage value at the end of the useful life will be \$5000. Maintenance costs are \$2000 for the first year and are estimated to increase by \$150 per year.

OPTION 2: The machine is leased for an initial payment of \$2000 plus annual payments of \$3500. There is no salvage value. A maintenance contract is purchased for a single payment of \$10,000 at the start of the lease period.

	Present Value of Item	
	OPTION 1	OPTION 2
Purchase/Lease		
Salvage Value		
Maintenance		
TOTAL		

B. (2 points) What is the equivalent annualized total cost, over the 8-year lifetime, for the machine with the lowest "present value of lifecycle cost"? Show your work.

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Problem 3. (12 points)

A. (4 points) Match each of the following terms to its definition. On the blank line in front of each term, write the letter corresponding to the best definition. In the definitions, "item" may refer to a component, element, module, system, etc.

- _____ Hierarchy a. dividing a single item at a particular level of abstraction into a set of items, typically at that same level of abstraction
- _____ Modularity b. describing items in such a way as to reduce interactions between items and increase self-containment and potential re-use
- _____ Partitioning c. dividing an item at one level of abstraction into multiple items at a lower level of abstraction
- _____ Decomposition d. a multi-level description in which an item at one level of abstraction is generally composed of multiple items at the next-lower level

B. (2 points) List two specific examples of the benefits of increased modularity. One example should relate to the design portion and one example should relate to the manufacturing portion of the product lifecycle.

C. (6 points) Briefly describe how partitioning would be used in the following examples of steps in the product design process. For each example, briefly explain the basis on which partitioning would occur, the principal expected benefit(s) of partitioning, and a significant potential disadvantage or weakness of partitioning at that step in the design process.

Preliminary design of a new automobile

Detailed circuit-level design of a large electronic system

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Problem 4. (10 points)

A. (4 points) During the design process, a product may be described at various levels of abstraction. For each of the following statements, check the appropriate box indicating if the statement more accurately describes a high-level or low-level product description.

	High-level	Low-level
The description emphasizes product functionality or behavior, rather than implementation.	<input type="checkbox"/>	<input type="checkbox"/>
It is relatively easy to determine specific product characteristics such as cost, timing, or component count.	<input type="checkbox"/>	<input type="checkbox"/>
The description is usually shorter, but may be ambiguous or incomplete.	<input type="checkbox"/>	<input type="checkbox"/>
It is relatively easy to modify the product description to reflect changes in user desires or expectations.	<input type="checkbox"/>	<input type="checkbox"/>

B. (6 points) Sustainability can be defined as doing things in a way that minimizes the negative effects on future generations. One approach to sustainability is to design products so that components can be re-used or recycled, rather than thrown away, at the end of their useful lifetime. Briefly discuss the effect of emphasizing re-use/recycling on the design process. Potential issues: What is difference between re-use and recycling? What key design decisions will most likely be affected? How does the expected product lifetime affect re-use or recycling? Be as specific as possible in your answer, including examples where possible.

Write your answer in the space remaining at the bottom of this page. Your answer is limited to this space only. DO NOT write (or continue) your answer on the back of this page or anywhere else on this exam.

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Problem 1. (12 points)

For this problem, place your final numerical answers in the boxes at the right margin. You **MUST** show your work (formulas and numeric values) to justify your answers. Correct answers without supporting work will not receive full credit.

- A. (4 points) A piece of manufacturing equipment costs \$27,000. Assuming a useful lifetime of six (6) years, a salvage value of \$8,000, and an interest rate of 5.0% per year, what is the annualized cost? If the company expects to produce an average of 1000 widgets per month, how much does this piece of equipment contribute to the cost of a widget?

Annualized Cost

Cost per Widget

- B. (8 points) A company has offered you two different payment plans for purchasing a product:

- Option 1: 15% down payment and 10 annual payments of \$1200.
- Option 2: no down payment and 12 annual payments of \$1500.

Treat the down payment as occurring at the end of year 0, with the annual payments occurring at the end of years 1 through n. Assume an interest rate of 5.0% per year. What is the total sale price (present value) for each option? What is the present value of the last annual payment under Option 2?

Option 1

Total Sale Price

Option 2

Total Sale Price

Present Value of Final Payment

Briefly explain why someone might choose the option that has the larger sale price.

Name: _____

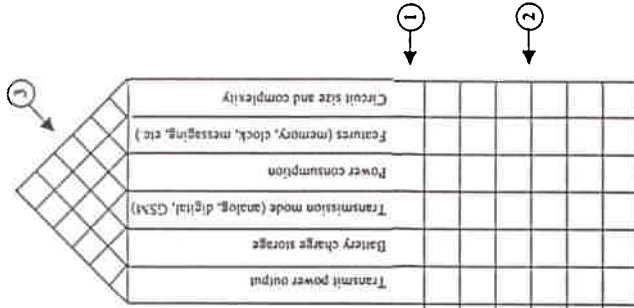
Student #: _____

Problem 3. (15 points)

This QFD diagram maps customer desires into engineering characteristics for a cellular phone.

- A. (6 points) Complete the three indicated sections of this QFD diagram by doing the following:

- (1) Precede each engineering characteristic by a "+" ("−") sign if it is generally desirable to increase (decrease) the value of that characteristic. This may not apply to some characteristics.
- (2) Place a "+" ("−") sign in the rectangular matrix to indicate that improving the engineering characteristic will improve (diminish) customer satisfaction in the indicated area.
- (3) Place a "+" ("−") sign in the triangular matrix to indicate that improving one engineering characteristic will improve (diminish) the other engineering characteristic.



In the space below, or on the back of this page, answer the following questions about this QFD diagram.

- B. (3 points) Identify two customer desires that are in conflict. Explain how this conflict is revealed in the QFD diagram. If there are no conflicting customer needs/desires, state so.
- C. (2 points) Based on the entries in your QFD diagram, what do you anticipate will be the most significant trade-off between two engineering characteristics? Explain the impact of this trade-off on the overall product design. If there are no engineering characteristics that involve trade-offs, state so.

- D. (3 points) Based on this QFD diagram, which engineering characteristic is probably the most important in determining overall success in satisfying customer desires? Why? How will determining the value for this characteristic affect other aspects of the design?