

Name: \_\_\_\_\_

Recitation Section: \_\_\_\_\_

Student Number: \_\_\_\_\_

1. Check that your exam includes all 7 pages (cover, 6 problems). Additionally, there are two formula sheets.
2. Read all instructions and problems carefully. Points will be deducted for failure to follow instructions.
3. Complete the information requested in the spaces above.
4. **PRINT** your name and student number in the spaces at the top of all remaining pages of this exam.
5. **Show ALL of your work on these pages.** The pages in this exam may be separated for grading; therefore, if you need extra space for a particular problem, write on the back of the page for that problem. The instructions for a specific question may limit the amount of space allowed for an answer. For all multiple choice questions, select the closest, or most appropriate, answer.
6. You are permitted one sheet (8 1/2 x 11, double-sided) of **handwritten** notes. Use of any other notes, books, or other resources is prohibited.
7. Calculators are permitted; however, you are not allowed to use the calculator memory to store notes, etc.
8. Cell phones are prohibited and must be turned off and stored during the exam.
9. This exam lasts for 65 minutes. Point values are listed for each problem to assist you in best using your time.

_____	Problem 1.	(20 points possible)
_____	Problem 2.	(20 points possible)
_____	Problem 3.	(15 points possible)
_____	Problem 4.	(15 points possible)
_____	Problem 5	(15 points possible)
_____	Problem 6	(15 points possible)
_____	<b>TOTAL.</b>	(100 points possible)

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**Problem 1. (20 points)**

Following are 10 statements. For each of the following statements, circle the appropriate response in the right-hand column. This problem is scored by # of points = 2 (number circled correctly) – 1 (number circled incorrectly). In other words, incorrect guesses hurt worse than no guesses.

- |   |             |              |
|---|-------------|--------------|
| A. In the video on engineering disasters the point was made that most disasters are related to a fundamental lack of knowledge of engineering or scientific principles. | <b>TRUE</b> | <b>FALSE</b> |
| B. The afternoon portion of the Fundamentals of Engineering Exam may be either general or discipline specific.  | <b>TRUE</b> | <b>FALSE</b> |
| C. In benefit-cost analysis, sometimes the same item may be classified as either a disbenefit or a cost.  | <b>TRUE</b> | <b>FALSE</b> |
| D. In designs where safety is a concern, the value of $C_p$ should be approximately equal to unity.   | <b>TRUE</b> | <b>FALSE</b> |
| E. A system composed of a highly reliable subsystem in parallel with a weakly reliable subsystem is more reliable than the highly reliable subsystem alone.             | <b>TRUE</b> | <b>FALSE</b> |
| F. Tort law is the branch of statutory law that deals with contract disputes.   | <b>TRUE</b> | <b>FALSE</b> |
| G. Engineering design patents fall under the category of "utility patents" and they are issued for 20 years.  | <b>TRUE</b> | <b>FALSE</b> |
| H. When considering the sum of two of random variables, the standard deviation of the sum is equal to the sum of the individual standard deviations.                    | <b>TRUE</b> | <b>FALSE</b> |
| I. A duty-based theory of morality is based on motives, attitudes, aspirations and ideals.  | <b>TRUE</b> | <b>FALSE</b> |
| J. Copyrights are valid for 50 years past the first public use of a book or document.   | <b>TRUE</b> | <b>FALSE</b> |

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**Problem 2. (20 points)**

A square notch is fabricated in 1,000,000 machined parts. Assume that the area of the notch is  $A = W \times L$ , where the notch dimensions are width =  $W$  and length =  $L$ .

Measurement of notch dimensions have established the following statistics:

Mean value of  $W = 0.525$  inches

Mean value of  $L = 0.375$  inches

Standard deviation of  $W = 0.007$  inches

Standard deviation of  $L = 0.012$  inches

Compute the expected mean and standard deviation for the area of the notch.

**Expected mean value of notch area A (5 pts) =** \_\_\_\_\_

**Expected standard deviation of notch area A (5 pts) =** \_\_\_\_\_

Notches either too large, or too small, in area are deemed to be defective. Assuming a  $C_p$  value of 1.5, specify the upper and lower specification limits for the area  $A$  of the notch.

**USL (3 pts)** \_\_\_\_\_

**LSL (3 pts)** \_\_\_\_\_

How many parts out of the batch of 1,000,000 are expected to be defective?

**Number of parts defective (4 pts)** \_\_\_\_\_

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**Problem 3. (15 points)**

A process is being evaluated to decide which choice of the three possible branches (A, B, or C) is preferred based upon a decision tree analysis with conditional uncertainties. Probabilities and expected payoff amounts are given, and the least expensive option should be chosen.

Branch A leads to a chance node with three output branches. Label these output branches as D, E, and F. The uncertainties for D, E, and F are as follows:  $\Pr(D)=0.2$ ,  $\Pr(E)=0.3$ , and  $\Pr(F)=0.5$ . Each output branch terminates at a separate payoff node.

Branch B leads to a chance node with two output branches. Label these output branches as G and H. The uncertainties for G and H are as follows:  $\Pr(G)=0.7$  and  $\Pr(H)=0.3$ . Each output branch terminates at a separate payoff node.

Branch C leads directly to a payoff node with an expected value of \$13,000

The expected values of the remaining payoff nodes are as follows:  $\text{Value}(D)=\$5000$ ,  $\text{Value}(E)=\$13,333$ ,  $\text{Value}(F)=\$12,000$ ,  $\text{Value}(G)=\$11,429$ , and  $\text{Value}(H)=\$13,333$

**Draw the decision tree for the above problem, and fill in the expected costs for each of the nodes (10 pts)**

**List the preferred process (A, B, or C) (2 pts) \_\_\_\_\_**

**Expected cost of the preferred process (A, B, or C) (3 pts) \_\_\_\_\_**

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**Problem 4. (15 points)**

A city is planning the construction of a golf course, and is considering two configurations with different expected payoffs and operating expenses. Determine which of the two options is most cost effective for the city. For 10 years of operation, and using an equivalent present value viewpoint, determine the benefit to cost ratio for each of the options. Assume an interest rate of 8%. Show all calculations to receive full credit.

Option 1: 18 hole golf course at a construction cost of \$10,000,000

The expected yearly revenue is:

A fee of \$35 is charged to each player with the following course usage probabilities (a) 100,000 players per year at a probability of 0.3, (b) 125,000 players per year at a probability of 0.5, and (c) 150,000 players per year at a probability of 0.2

The expected yearly operating costs for option #1 are:

\$2,500,000 per year

Option 2: Professional Quality 18 hole golf course at a construction cost of \$15,000,000

The expected yearly revenue is:

A fee of \$95 is charged to each player with the following course usage probabilities (a) 25,000 players per year at a probability of 0.1, (b) 50,000 players per year at a probability of 0.3, (c) 75,000 players per year at a probability of 0.4, and (d) 100,000 players per year at a probability of 0.2

The expected yearly operating costs for option #1 are:

\$4,000,000 per year

**Benefit to cost ratio for option #1 (5 pts) \_\_\_\_\_**

**Benefit to cost ratio for option #2 (5 pts) \_\_\_\_\_**

**Result: Choose best option (5 pts) \_\_\_\_\_**

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**Problem 5. (15 points)**

A manufacturing design for capacitors is characterized by the following values:

Lower Specification Limit = 0.085 microfarads

Upper Specification Limit = 0.115 microfarads

Target Mean = 0.1 microfarads

Actual Mean = 0.098 microfarads

Standard Deviation = 0.01 microfarads

Assume that the characteristics of the manufactured item are distributed according to a normal (Gaussian) distribution. Compute the values specified below. Show all calculations to receive full credit.

**Cp (3 pts)** \_\_\_\_\_

**Cpk (3 pts)** \_\_\_\_\_

**% Defects below LSL (3 pts)** \_\_\_\_\_

**% Defects above USL (3 pts)** \_\_\_\_\_

Which one of the three descriptions would be most likely used to describe the above process? Circle the letter of the correct response below. **(3 pts)**

- (a) The process is capable
- (b) The process is incapable
- (c) The process and the design agree at the 3 sigma points

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**Problem 6. (15 points)**

For each of the following questions, circle the letter in the right-hand column that corresponds to the best answer. Show all calculations to get full credit.

A. 15,000 devices are being tested for 300 hours. The process is characterized by a per unit failure rate of  $4 \times 10^{-3} \text{ hr}^{-1}$ . How many devices fail between 200 and 250 hours of their life. **a b c d**

- (a) 851 (c) 1563  
(b) 1222 (d) 2368

B. A manufacturing process has an average defect rate of 1.3 defects per unit. What is the probability that a particular unit will have 4 defects? **a b c d**

- (a) 3.2% (c) 14.8%  
(b) 9.7% (d) 18.2%

C. A part is assembled by one of two employees. The percentage of the parts assembled by employee #1 is 40%, and the percentage by employee #2 is 60%. Employee #1 has an assembly defect rate of 5%, and employee #2 has a defect rate of 8%. One part is found to be defective, and may have been assembled by either employee. What is the probability that it was assembled by employee #1. **a b c d**

- (a) 18.5% (c) 32.1%  
(b) 29.4% (d) 38.7%