

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

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

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

1. Check that your exam includes all 7 pages (cover, 6 problems, and one 2-sided formula sheet).
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.
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. This exam lasts for 65 minutes. Point values are listed for each problem to assist you in best using your time.

_____	Problem 1.	(24 points possible)
_____	Problem 2.	(12 points possible)
_____	Problem 3.	(15 points possible)
_____	Problem 4.	(18 points possible)
_____	Problem 5.	(16 points possible)
_____	Problem 6.	(15 points possible)
_____	<b>TOTAL.</b>	(100 points possible)

**Manufacturing-Related Formulas**

$$C_p = (USL - LSL) / (6 \sigma) \quad C_{pk} = C_p (1 - k)$$

$$k = | \text{Actual Mean} - \text{Target Mean} | / ((USL - LSL) / 2)$$

$$\text{First-time yield, FTY} = e^{-dpu} \quad \text{Prob} \{ k \text{ defects} \} = (dpu)^k / k! e^{-dpu}$$

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**Problem 1. (24 points)**

- (a) State one advantage and one disadvantage of building a prototype instead of performing a simulation of a system

Advantage \_\_\_\_\_

Disadvantage \_\_\_\_\_

- (b) State one reason why recycling might not be economically feasible

Reason \_\_\_\_\_

- (c) State one reason why perceived risk might be different from actual risk.

Reason \_\_\_\_\_

- (d) In practice, are most standards design standards or performance standards (circle one below)? State a reason why.

Design

Performance

Why \_\_\_\_\_

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**Problem 2. (12 points)**

For each of the ethical systems on the left, select the most appropriate descriptive phrase from the list on the right. Each phrase may be used only once.

- |                       |  |
|-----------------------|--|
| A. Duty-based _____   | (a) Emphasis is on results                       |
| B. Rights-based _____ | (b) Emphasis is on obligations to others         |
| C. Utilitarian _____  | (c) Emphasis is on values                        |
| D. Virtue-based _____ | (d) Emphasis is on maximization of personal gain |
|                       | (e) Emphasis is on those affected                |

**Problem 3. (15 points)**

A manufacturing process is characterized by the following values:

$$C_p = 2.0 \quad C_{pk} = 1.6 \quad \text{Target mean} = 600 \quad \text{Actual mean} = 560$$

Assume design specifications are symmetric around the target mean and that the characteristics of the manufactured item are distributed according to a normal (Gaussian) distribution. Compute the values specified below. You must show your calculations in the space below (or on the back of *this* page) in order to receive full credit.

- Lower specification limit: \_\_\_\_\_
- Upper specification limit: \_\_\_\_\_
- Standard deviation: \_\_\_\_\_
- Defects below LSL  
(in terms of tail-end Z function): \_\_\_\_\_
- Defects above USL  
(in terms of tail-end Z function): \_\_\_\_\_

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**Problem 4. (18 points)**

For each of the following questions, circle the letter in the right-hand column that corresponds to the best answer.

- A. 10,000 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 300 hours of their life? **a b c d**
- (a) 1026 (c) 4493  
(b) 1480 (d) 8520
- B. A manufacturing process has an average defect rate of 1.6 defects per unit. What is probability that a particular unit will have more than 1 defect? **a b c d**
- (a) 20.2 % (c) 47.5 %  
(b) 32.3 % (d) 79.8 %
- C. A manufacturing process step, involving test with perfect repair and 100% coverage, has a first-time yield (FTY) of 30.1%. While producing 1000 good units, approximately how many total tests will have to be performed? **a b c d**
- (a) 1,200 (c) 3,010  
(b) 2,200 (d) 6,990
- D. Determine the value of the 20<sup>th</sup> payment for a gradient series, whose first payment is \$200, and each subsequent payment is 6% greater than the previous payment **a b c d**
- (a) \$605  
(b) \$641  
(c) \$1248  
(d) \$2400
- E. While performing a benefit-cost analysis of a proposed dam of a river, an engineers is confronted with the decision as to whether to represent the additional commuting miles that some residents will have to drive daily as a cost or as a reduction of benefits. This decision is representative of the issue of: **a b c d**
- (a) classification of a tangible  
(b) quantification of an intangible idea  
(c) a fundamental assumption in the analysis as to what should be included  
(d) whether to use the B-C difference or the B/C ratio.
- F. An international oil company owns the assets listed below. Select the one that is not a form of intellectual property. **a b c d**
- (a) copyright on a textbook on refinery construction  
(b) deep-water oil pumping rig in the Persian Gulf  
(c) patent on the refining process  
(d) trade mark of the company logo.

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**Problem 5. (16 points)**

Following are 8 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 correctly circled) – 1 (number incorrectly circled). In other words, incorrect guesses hurt worse than no guesses.

- |  |             |              |
|--|-------------|--------------|
| (a) If one becomes a licensed professional engineer by passing the Principles and Practice Exam in the electrical discipline, one must pass another exam in the mechanical discipline before one can legally perform mechanical work as a PE.              | <b>TRUE</b> | <b>FALSE</b> |
| (b) Under the doctrine of strict liability, negligence does not have to be proved before a corporation is legally liable.  | <b>TRUE</b> | <b>FALSE</b> |
| (c) Most government standards for products are stated in the form of design standards, as opposed to performance standards.  | <b>TRUE</b> | <b>FALSE</b> |
| (d) It is possible to obtain a patent without a working model.   | <b>TRUE</b> | <b>FALSE</b> |
| (e) The Hindenberg disaster was fundamentally due to the lack of understanding that hydrogen gas is potentially highly explosive.  | <b>TRUE</b> | <b>FALSE</b> |
| (f) A definition of the term “ukase” is a regulatory ruling with the force of law.   | <b>TRUE</b> | <b>FALSE</b> |
| (g) A system composed of a two weakly reliable subsystems in parallel is always less reliable than a single weakly reliable subsystem alone, assuming all three systems have equal reliabilities.  | <b>TRUE</b> | <b>FALSE</b> |
| (h) If two subsystems are characterized by constant per-unit failure rates, then the parallel combination is characterized by a constant per-unit failure rate that is the product of the two separate rates divided by the sum of the two separate rates. | <b>TRUE</b> | <b>FALSE</b> |

**Scoring:**        \_\_\_\_\_ correct answers x 2pts =        \_\_\_\_\_

                      minus number of incorrect answers    –        \_\_\_\_\_

Score:

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**Problem 6. (15 points)**

A public transit authority is basing a decision on which of two possible systems to design and build on benefit-cost analysis. Since the projected public benefit depends on ridership of the new system, a decision theory model for the projected benefit is used (dollar amounts are in millions). Both systems last eight years, and an interest rate of 6% is appropriate. Using an equivalent **annualized value** viewpoint, determine which system should be chosen by (a) determining expected benefit (not considering cost) of each project, and (b) benefit-cost ratio. State your justification and result.

System Alpha:

cost: \$ 400 per year

generates benefit of: \$ 600 per year with probability =.6, **OR**  
\$ 400 per year with probability =.3, **OR**  
\$ 200 per year with probability =.1

System Beta:

cost: \$ 600 per year

generates benefit of: \$ 800 per year with probability =.4, **OR**  
\$ 600 per year for the first four years  
\$ 800 per year for the last four years  
with probability =.6

(a)

expected annualized benefit of Alpha \_\_\_\_\_

expected annualized benefit of Beta \_\_\_\_\_

(b)

Alpha B/C = \_\_\_\_\_

Beta B/C = \_\_\_\_\_

Result: Choose System \_\_\_\_\_