

Name: _____

Recitation Section: L _____

Student Number: _____

1. Check that your exam includes all 9 pages (cover, 5 problems, one 2-sided formula sheet, and one interest table).
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 55 minutes. Point values are listed for each problem to assist you in best using your time.

_____	Problem 1.	(16 points possible)
_____	Problem 2.	(20 points possible)
_____	Problem 3.	(20 points possible)
_____	Problem 4.	(20 points possible)
_____	Problem 5.	(24 points possible)
_____	TOTAL.	(100 points possible)

Manufacturing-Related Formulas

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

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

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

Problem 1. (16 points)

(a) (4) State two reasons why perceived risk may be different from actual risk.

(b) (4) In benefit-cost analysis, is the benefit-cost difference or the benefit-cost ratio usually used? State the reason

Difference or Ratio (circle one)

Reason _____

(c) (4) State one disadvantage of performing a single long simulation and one disadvantage of performing many very short simulations of a system, instead of several intermediate length simulations.

Disadvantage of single long _____

Disadvantage of many short _____

(d) (4) State one advantage and one disadvantage of performing experiment-based design.

Advantage _____

Disadvantage _____

Problem 2. (20 points)

A manufacturing process that involves the insertion of a soldered part into a printed circuit board is characterized by following values:

$$C_p = 0.8$$

$$C_{pk} = 0.752$$

$$\text{Upper specification limit of the resistance of the joint} = 3.6 \times 10^{-6} \text{ ohms}$$

$$\text{Lower specification limit of the resistance of the joint} = 1.2 \times 10^{-6} \text{ ohms}$$

Assume that the characteristics of the manufactured item are distributed according to a normal (Gaussian) distribution. Also assume that the upper and lower specification limits are symmetric about the target mean. Compute the values specified below. You must show your calculations in the space below in order to receive full credit.

Standard deviation of the resistance _____

Fractional shift of the actual mean from the target mean. _____

Defects below LSL
(in terms of tail-end Z function): _____

Defects above USL
(in terms of tail-end Z function): _____

Problem 3 . (20 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 500 hours. The process is characterized by two sub-systems with series reliabilities characterized by per unit failure rates of $3 \times 10^{-3} \text{ hr}^{-1}$ and $1 \times 10^{-3} \text{ hr}^{-1}$. How many devices survive past 400 hours of their life? **a b c d**
(a) 2019 (c) 4493
(b) 2474 (d) 7696
- B. A similar group of 10,000 devices is characterized by two sub-systems with parallel reliabilities with the same per unit failure rates of $3 \times 10^{-3} \text{ hr}^{-1}$ and $1 \times 10^{-3} \text{ hr}^{-1}$. How many of these devices survive past 400 hours of their life? **a b c d**
(a) 2019 (c) 4493
(b) 2474 (d) 7696
- C. A manufacturing process has an average defect rate of 1.8 defects per unit. What is probability that a particular unit will have less than two defects? **a b c d**
(a) 29.8 % (c) 53.7.3 %
(b) 46.3 % (d) 84.5 %
- D. A manufacturing process step, involving inspection with perfect repair and 100% coverage, has a first-time yield (FTY) of 65%. While producing 1000 good units, approximately how many total inspections will have to be performed? **a b c d**
(a) 301 (c) 1,431
(b) 1,350 (d) 1,650
- E. A manufacturing line produce microprocessors whose average maximum operating clock speed is 160 MHz. Assuming a normal distribution of maximum operating speeds and a standard deviation of 30 MHz, approximately what percentage of microprocessors will operate correctly at 124 MHz? **a b c d**
(a) less than 8 % (c) 88.5 %
(b) 11.5 % (d) 93.3 %
- F. A system composed of two parallel subsystems of reliability .4 and .6 respectively, has a system reliability of **a b c d**
(a) .24 (c) .76
(b) .48 (d) 1.4
- G. Which one of the following characteristics or sets of characteristics listed below is not discussed in the Stancell Leadership module as a characteristic of a servant leader? **a b c d**
(a) commitment to the organization and its members;
(b) exhibiting leadership behavior, including vision and integrity;
(c) ability to develop and implement a complex organizational plan;
(d) willingness to delegate and empower others.

- H. While performing a benefit-cost analysis of a rapid transit system, an engineers is confronted with the decision as to the dollar amount to assign to represent the perception of increased safety, which would result from the hiring of additional transit police. This decision is representative of: **a b c d**
- (a) quantification of an intangible idea
 - (b) a fundamental assumption in the analysis as to what should be included
 - (c) classification of a tangible
 - (d) whether to use the B-C difference or the B/C ratio.
- I. In the video on engineering disasters the point was made that most disasters are related to a **a b c d**
- (a) rare combination of unexpected events
 - (b) clearly defined ethical lapse
 - (c) fundamental lack of knowledge of engineering or scientific principles
 - (d) management communication failure
- J. Two resistors are wired in series connection to form an equivalent resistance $R = R_1 + R_2$. R_1 has a value of 1 Kiloohm, with a tolerance of 2.0%, and R_2 has a value of 2 Kiloohms, with a tolerance of 3.0%. The tolerance in the specification represents absolute upper and lower values. Which one of the following statements is correct? **a b c d**
- (a) The equivalent resistance is equal to 3 Kiloohms with a tolerance of 2.0%.
 - (b) The equivalent resistance is equal to 3 Kiloohms with a tolerance of 2.7%
 - (c) The equivalent resistance is equal to 3 Kiloohms with a tolerance of 3.0%.
 - (d) The equivalent resistance is equal to 3 Kiloohms with a tolerance of 5.0%.

Problem 4. (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 correctly circled) – 1 (number incorrectly circled). In other words, incorrect guesses hurt worse than no guesses.

- | | | |
|---|-------------|---------------|
| (a) The failure of the walkways in the Hyatt Regency hotel was primarily the result of errors in the original design specifications. | TRUE | FALSE |
| (b) The doctrine of strict liability usually provides an easier standard for a plaintiff to achieve than does the proof of negligence in order that a corporation be held legally liable for harm caused by a product. | TRUE | FALSE |
| (c) A definition of the term “ukase” is a regulatory ruling with the force of law. | TRUE | FALSE. |
| (d) Assuming that the initial payment of a series of 10 annual payments is \$200, then a geometric series of payment increasing 8% a year has necessarily a lower present value than an arithmetic series increasing \$16 per year for any non-zero, positive interest rate | TRUE | FALSE |
| (e) The morning portion of the Fundamentals of Engineering Exam does not include questions on ethics or on engineering economy. | TRUE | FALSE |
| (f) If a company has complied with ISO 9000:2000 standards, it means that a majority of customers have indicated that they are satisfied with the product | TRUE | FALSE |
| (g) The “infant mortality” region of the “bathtub” model of device reliability is typically characterized by a decreasing per-unit failure rate. | TRUE | FALSE |
| (h) The roof-top portion of the QFD diagram describes the trade-off between the consumer desires and the engineering requirements. | TRUE | FALSE |
| (i) The decision to classify a tangible factor as either a cost or as a disbenefit affects the benefit-cost ratio. | TRUE | FALSE |
| (j) Most government standards for products are stated in the form of design standards, as opposed to performance standards. | TRUE | FALSE |

Scoring: _____ correct answers x 2pts = _____
 minus number of incorrect answers – _____

Score:

Problem 5. (24 points)

A company is making a decision on which of three possible alternatives to design and build. A decision theory model for the projected revenue is to be used (dollar amounts are in millions). All systems cost the same, and each lasts for 8 years. An interest rate of 6% is appropriate. Using an equivalent **annualized value** viewpoint, determine the annualized value of expected revenue of each alternative and determine which alternative should be chosen. State your justification and result.

Credit will be given for an approximate calculation, provided detailed justification for choice of alternative is provided.

Alternative #1 generates revenue of:

\$ 2100 per year with probability = .8, **OR**

\$ 1000 per year for years # 1,3,5,7 and

\$ 5000 per year for years # 2,4,6,8,
with probability = .2

Alternative #2 generates revenue of:

\$ 2900 per year with probability = .7, **OR**

\$ 4000 per year for years # 1,3,5,7,

\$ 0 per year for years # 2,4,6,8,
with probability = .3

Alternative #3 generates revenue of:

9 annual payments of \$2000, the first payment occurring immediately,
with probability = 1

Alternative #1 expected revenue (annualized value) = _____

Alternative #2 expected revenue (annualized value) = _____

Alternative #3 expected revenue (annualized value) = _____

Choose alternative # _____