

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** (no photocopies or reductions) notes. Use of any other notes, books, or other resources is prohibited. **No cellular telephones** are permitted.
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.	(20 points possible)
_____	Problem 2.	(25 points possible)
_____	Problem 3.	(18 points possible)
_____	Problem 4.	(20 points possible)
_____	Problem 5.	(17 points possible)
_____	TOTAL.	(100 points possible)

Manufacturing-Related Formulas

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

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

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

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Problem 1. (20 points)

- (a) (6) 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 _____

- (b) (8) State some of the factors that contributed to the occurrence or the extent of the following disasters, other than the primary factor

Example: For the Hindenberg, the electrical spark was the primary factor, flammable paint a secondary factor.

Titanic: _____

Bhopal: _____

Challenger: _____

Hyatt Walkway: _____

- (c) (6) Are most government standards written in the form of design standards or performance standards? State a reason.

Design or Performance (circle one)

Reason _____

Problem 2. (25 points)

- (a) (10) The first payment in a geometrical gradient series of 8 payments is \$1,800, and occurs one year from the present. Each payment increases by 4% over the preceding payment, and the interest rate appropriate to the calculation is 8%. Determine the amount of the last payment and the present value of the entire series. Show all calculations.

Last payment _____

Present value of series _____

- (b) (10) We wish to convert a series of 9 equal annual payments of \$2,000, the first payment, occurring immediately, to an equivalent arithmetic gradient series of 8 payments, the first occurring a year from the present. The first payment is also \$2,000. The interest rate appropriate to the calculation is 8%. Determine the present value of the series and the amount of the gradient increase of each payment over the previous payment. Show all calculations.

Present value of series _____

Gradient Increase _____

- (c) (5) Rank the five 12 year revenue plans below in order of highest present value of revenue. The first revenue payment occurs one year from the present in all cases. Assume an interest rate of 8%.

(A) \$4000 per year for 12 years

(B) \$8,000 per year for the first six years
\$0 per year for the last six years

(C) \$6,000 per year for the first eight years
\$0 per year for the last four years

(D) \$2,000 per year in odd years (1,3...)
\$6,000 per year in even years (2,4...)

(E) \$5,000 per year in odd years (1,3...)
\$3,000 per year in even years (2,4...)

Rank Order (Highest first)

Problem 3. (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 500 hours. The process is characterized by two sub-systems with parallel reliabilities of 0.3 and 0.6 at 200 hours. Determine the number of these devices that have failed before 200 hours of their life? **a b c d**
(a) 2800 (c) 7200
(b) 6400 (d) 8400
- B. A group of 2,000 devices is characterized by two sub-systems with series reliabilities characterized by per unit failure rates of $2 \times 10^{-3} \text{ hr}^{-1}$ and $3 \times 10^{-3} \text{ hr}^{-1}$. How many of these devices have survived past 200 hours of their life? **a b c d**
(a) 238 (c) 1554
(b) 736 (d) 1980
- C. A manufacturing process has an average defect rate of 1.6 defects per unit. What is the probability that a particular unit will have less than three defects? **a b c d**
(a) 21.7 % (c) 52.5 %
(b) 47.4 % (d) 78.3 %
- D. A manufacturing process step, involving inspection with perfect repair and 100% coverage, has a first-time yield (FTY) of 35%. While producing 4,000 good units, approximately how many total inspections will have to be performed? **a b c d**
(a) 1,400 (c) 2,800
(b) 2,600 (d) 6,600
- E. A manufacturing line produce data buses whose average maximum operating rate is 180 MB/sec. Assuming a normal distribution of maximum operating rates and a standard deviation of 40 MB/sec, approximately what percentage of buses will operate correctly at 120 MB/sec? **a b c d**
(a) less than 8 % (c) 88.5 %
(b) 11.5 % (d) 93.3 %
- F. While performing a benefit-cost analysis of a proposed new bridge, an engineer must determine the dollar amount to assign to represent the effect of the change in residents' view because of the height of the earthworks. This determination is representative of: **a b c d**
(a) quantification of an intangible item
(b) quantification of a tangible item
(c) classification of a intangible item
(d) classification of an tangible item.

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) It is possible to obtain a patent without a working model. | TRUE | FALSE |
| (b) An advantage of experiment-based design compared to theoretical-based design is that experiment-based design provides a more realistic representation of manufacturing variations | TRUE | FALSE |
| (c) A definition of the term “ukase” is a regulatory ruling with the force of law. | TRUE | FALSE |
| (d) A potential advantage of building a prototype compared to performing a simulation is that it is easier to discover unforeseen interactions among the system components. | TRUE | FALSE |
| (e) For the afternoon portion of the Fundamentals of Engineering Exam, one must take an examination in one’s chosen discipline (e.g., electrical engineering). | 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) If the reliability of a device can be characterized by a two parallel reliabilities with two constant per unit failure rates, then its overall per unit failure rate is constant with time. | TRUE | FALSE |
| (h) The morning portion of the Fundamentals of Engineering Exam does not include questions on ethics or on engineering economy. | TRUE | FALSE |
| (i) The Baldrige Award is given for outstanding technical design of a new product. | TRUE | FALSE |
| (j) The fundamental canons of the ABET Code of ethics is quite similar to the NCEES Model Rules of Professional Conduct, because both emphasize public safety and welfare. | TRUE | FALSE |

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

Score:

Problem 5. (17 points)

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

$$C_p = .87$$

$$C_{pk} = .80$$

$$\text{Upper specification limit of the resistance of the joint} = 4.0 \times 10^{-6} \text{ ohms}$$

$$\text{Lower specification limit of the resistance of the joint} = 1.6 \times 10^{-6} \text{ ohms}$$

(14) 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. For the last two parts, assume that the actual mean is greater than the target mean.

Standard deviation of the resistance _____

Fractional shift of the actual mean
from the target mean (absolute value) _____

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

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

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

- (a) The design is tolerant
- (b) The design is intolerant
- (c) The design and the manufacturing process agree at the 3 sigma points