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

Manufacturing-Related Formulas

$Cp = (USL - LSL) / (6 \text{ sigma})$ $Cpk = Cp (1 - k)$

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

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

Problem 1. (20 points)

(a) (4) State two reasons why perceived risk may be viewed as less than actual risk.

_____

_____

(b) (4) Are most government standards written in the form of design standards or performance standards? State a reason.

Design or Performance (circle one)

Reason_____

(c) (6) The last payment in a geometrical gradient series of 8 payments is $1,200. Each payment increases by 4% over the preceding payment, and the interest rate appropriate to the calculation is 8%. Determine the amount of the first payment and the present value of the entire series. Show all calculations.

First payment_____

Present value of series_____

(d) (6) A highway rest area is to be analyzed using a benefit-cost analysis. One item to be included is the annual maintenance expense of $450,000. What is the economic justification of treating this item as a disbenefit instead of a cost? Would this treatment result in a larger or smaller benefit-cost ratio (assuming that the highway rest area is justified)?

Justification_____

Larger or Smaller (circle one)

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:

Cp=.8

Cpk=.752

Upper specification limit of the resistance of the joint = 4.8×10^{-6} ohms

Lower specification limit of the resistance of the joint = 1.6×10^{-6} 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 _____

Percentage 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 . (16 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 300 hours. Determine the per–unit failure rate at 300 hours. **a b c d**

(a) 2.3×10^{-4} hr^{-1}
(b) 1.1×10^{-3} hr^{-1}
(c) .28 hr^{-1}
(d) .72 hr^{-1}

B. A group of 10,000 devices is characterized by two sub-systems with series reliabilities characterized by per unit failure rates of $3x10^{-3}$ hr^{-1} and $1x10^{-3}$ hr^{-1}. How many of these devices survive past 400 hours of their life? **a b c d**

(a) 2019
(b) 2474
(c) 4493
(d) 7981

C. A manufacturing process has an average defect rate of 1.8 defects per unit. What is the probability that a particular unit will have two or more defects? **a b c d**

(a) 29.8 %
(b) 46.3 %
(c) 53.7.3 %
(d) 84.5 %

D. A manufacturing process step, involving testing with perfect repair and 100% coverage, has a first-time yield (FTY) of 75%. While producing 1000 good units, approximately how many total tests will have to be performed? **a b c d**

(a) 301
(b) 1,350
(c) 1,288
(d) 2,877

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 %
(b) 11.5 %
(c) 88.5 %
(d) 93.3 %

F. While performing a benefit-cost analysis of a proposed new dam, an engineer must determine the dollar amount to assign to represent the effect of the change in scenery in an adjoining vacation resort area. 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 tangible item
(d) classification of an intangible item.

G. 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

H. Two resistors are wired in series connection to form an equivalent resistance **a b c d**
R =2R1 + R2. (R1 is repeated).R1 has a mean value of 1 Kilohm, with a variance of 0.3 kilohm^2, and R2 has a mean value of 2 Kilohms, with a variance of 0.4 kilohm^2.
Which one of the following statements is correct?

(a)The equivalent resistance is equal to 4 Kilohms with a variance of 0.7 kilohm^2

(b) The equivalent resistance is equal to 4 Kilohms with a variance of 1.0 kilohm^2

(c) The equivalent resistance is equal to 4 Kilohms with a variance of 1.2 kilohm^2

(d) The equivalent resistance is equal to 4 Kilohms with a variance of 1.6 kilohm^2

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 Challenger rocket disaster was primarily the result of a misunderstanding of the temperature dependence of the O-ring hardness.	**TRUE**	**FALSE**
(b) The doctrine of strict liability usually provides a more difficult 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) A product whose design is based on "worst-case" analysis is typically more expensive to manufacture than is a product whose design is based on standard tolerances and means.	**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 Baldridge 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 different from the NCEES Model Rules of Professional Conduct, because the NCEES rules emphasize public safety, while the ABET code is strictly academically concerned.	**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 6 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:

$ 3200 per year with probability =.7, **OR**

$ 3000 per year for the first three years and
$ 6000 per year for the last three years,
with probability =.3

Alternative #2 generates revenue of:

$ 8,000 immediately with probability =.8, **OR**

$ 8,000 per year for years # 1,3,5 and
$ 0 per year for years # 2,4,6,
with probability =.2

Alternative #3 generates revenue of:

7 annual payments of $4,000, 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 #_____

Justification_____