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.	(20 points possible)
_____	Problem 2.	(12 points possible)
_____	Problem 3.	(16 points possible)
_____	Problem 4.	(18 points possible)
_____	Problem 5.	(18 points possible)
_____	Problem 6.	(16 points possible)
_____	**TOTAL**.	(100 points possible)

Manufacturing-Related Formulas

$Cp = (USL - LSL) / (6\ )$ $Cpk = Cp\,(1 - k)$

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

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

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Problem 1. (20 points)

A production process for power cables requires a self-inductance less than 4.00×10^{-6} henrys/meter. It is assumed that the self-inductance is a random variable that may be modeled as a normal distribution. Three batches, of 20,000 cables each, are produced, with a mean and standard deviation of

Batch A: mean= 1.75×10^{-6} henrys/m

Standard deviation = 3.00×10^{-6} henrys/m

Batch B: mean= 2.20×10^{-6} henrys/meter

Standard deviation= 1.00×10^{-6} henrys/m

Batch C: mean= 2.50×10^{-6} henrys/m

Standard deviation= 1.50×10^{-6} henrys/m

Which batch has the least number of expected defects, and what is that expected number? Justify your answer.

Batch_____

Number=_____

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Problem 2. (12 points)

One approach to sustainable design is to design products that can be reused or recycled during their useful lifetimes. For each of the design considerations listed below, indicate whether it is more associated with design for potential reuse or potential recycling

Use of certain modular components _____

Use of easily separable materials _____

Development of very long product lifetimes _____

Problem 3. (16 points)

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

Lower specification Limit = 32 Kilohms
Upper specification Limit = 50 Kilohms
Target mean = 41 Kilohms
Actual mean = 38 Kilohms
Standard Deviation = 8 Kilohms

Assume 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.

Cp: _____

Cpk: _____

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

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

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 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 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 200 hours. The process is characterized by a per unit failure rate of $5x10^{-3}$ hr^{-1}. How many devices fail between 100 and 150 hours of their life? **a b c d**

(a) 1342
(b) 2583
(c) 3935
(d) 6065

B. A manufacturing process has an average defect rate of 1.6 defects per unit. What is probability that a particular unit will have 3 defects? **a b c d**

(a) 0 %
(b) 5.8 %
(c) 13.8 %
(d) 16.1 %

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

(a) 1,125
(b) 1,250
(c) 1,500
(d) 1,750

D. The term "coverage," as defined in recitation, means: **a b c d**

(a) the fraction of all defects, on average, detected by a particular inspection;
(b) the first time yield after a single inspection of all devices;
(c) the inverse of the first time yield, after a single inspection of all devices;
(d) the fraction of defects that an inspection is designed to detect, that are actually detected.

E. 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.

F. In the video on engineering disasters the point was made that most disasters are related to a **a b c d**

(a) management communication failure
(b) clearly defined ethical lapse
(c) fundamental lack of knowledge of engineering or scientific principles
(d) rare combination of unexpected events

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Problem 5. (18 points)

Following are 9 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.	For the afternoon portion of the Fundamentals of Engineering Exam, one must take **a** discipline specific exam.	**TRUE**	**FALSE**
B.	Under the doctrine of strict liability, negligence must be proved before a corporation is legally liable.	**TRUE**	**FALSE**
C.	Most government standards for products are stated in the form of design standards, as opposed to performance standards.	**TRUE**	**FALSE**
D.	It is possible to obtain a patent without a working model.	**TRUE**	**FALSE**
E.	Given a uniform series of payments over n years at interest rate i, there is a geometric gradient series of payments also over n years at interest rate i that has the same value.	**TRUE**	**FALSE**
F.	A patent application must disclose enough information for the idea to be duplicated by others, and the patent application is publicly available.	**TRUE**	**FALSE**
G.	In design for manufacturability, the value of Cp should be made as small as possible.	**TRUE**	**FALSE**
H.	A system composed of a highly reliable subsystem in parallel with a weakly reliable subsystem is always more reliable than the highly reliable subsystem alone.	**TRUE**	**FALSE**
I.	The useful lifetime region of the "bathtub" model of device reliability is typically characterized by a constant per-unit failure rate.	**TRUE**	**FALSE**

Scoring: _____ correct answers x 2pts = _____

minus number of incorrect answers – _____

Score:

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Problem 6. (16 points)

A public transit authority is basing a decision on which of two possible systens 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 preojected benefit is used (dollar amounts are in millions). Both systems last six years, and an interest rate if 8% is appropriate. Using an equivalent present 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: $1,000

generates benefit of: $ 200 per year with probability =.6, **OR**

$ 250 per year with probability =.3, **OR**

$ 300 per year with probability =.1

System Beta:

cost: $1,800

generates benefit of: $ 200 per year with probability =.4, **OR**

$ 600 per year for the first three years
$ 800 per year for the last three years
with probability =.6

(a)

expected benefit of Alpha_____

expected benefit of Beta_____

(b)

Result: Choose System_____