

Name: _____

Recitation Section: L _____

Student Number: _____

1. Check that your exam includes all 6 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.	(15 points possible)
_____	Problem 4.	(18 points possible)
_____	Problem 5.	(18 points possible)
_____	Problem 6.	(16 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 production process for power cables requires a resistance less than 4.0×10^{-6} ohms/meter. The first batch of 10,000 cables are produced and found to have resistance that may be modeled as a normal distribution, with a mean and standard deviation of

$$\text{Mean} = 2.2 \times 10^{-6} \text{ ohms}$$

$$\text{Standard deviation} = 1.0 \times 10^{-6} \text{ ohms}$$

(i) If a second batch of 10,000 is to be produced with a mean of 3.0×10^{-6} ohms, what must be its standard deviation to have the same number of cables as that of the first batch that meet the resistance criterion?

(ii) What is the total expected number of cables, counting both batches, that fail to meet the resistance criterion? Justify your answer.

Standard deviation = _____

Number = _____

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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 _____

B. Rights-based _____

C. Utilitarian _____

D. Virtue-based _____

(a) Emphasis is on results

(b) Emphasis is on obligations to others

(c) Emphasis is on those affected

(d) Emphasis is on maximization of personal gain

(e) Emphasis is on values

Problem 3. (15 points)

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

Lower specification Limit = 16 Kilohms

Upper specification Limit = 28 Kilohms

Target mean = 22 Kilohms

Actual mean = 24 Kilohms

Standard Deviation = 3 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

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 $5 \times 10^{-3} \text{ hr}^{-1}$. How many devices have failed in the first 100 hours? **a b c d**
(a) 2583 (c) 6065
(b) 3935 (d) 7328
- B. A manufacturing process has an average defect rate of 1.8 defects per unit. What is probability that a particular unit will have 3 defects? **a b c d**
(a) 0 % (c) 5.8 %
(b) 5.4 % (d) 16.1 %
- C. A manufacturing process without repair has a first-time yield (FTY) of 86%. While producing 1000 good units, approximately how many total units will have to be manufactured? **a b c d**
(a) 1,140 (c) 1,714
(b) 1,163 (d) 2,162
- 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 inclusion of an items: an increase in commuter parking fees, which could be either treated as a reduction of future benefits or as an increase in project costs. 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. Two of the four types of capital, as defined relating to sustainability, are **a b c d**
(a) human capital and management capital
(b) management capital and financial capital
(c) natural capital and intellectual capital
(d) sustainable and non-sustainable capital

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Problem 6. (16 points)

A supplier of space shuttle equipment is trying to decide which of two possible systems to produce for NASA, who views them to be equivalent. (dollar amounts are in millions). Both systems last eight years, and an interest rate of 4% is appropriate. Using decision theory and an annualized or present value viewpoint, which system should be chosen. State your view, justification and result.

System Alpha generates revenue of: \$ 210 per year with probability = .8, **OR**

\$ 100 per year for years # 1,3,5,7 and
\$ 500 per year years # 2,4,6,8,
with probability = .2

System Beta generates revenue of: \$ 290 per year with probability = .7, **OR**

\$ 400 per year for years # 1,3,5,7,
\$ 0 per year for years # 2,4,6,8,
with probability = .3

Viewpoint: _____

Justification/calculation:

Result: Choose System _____