

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.	(24 points possible)
_____	Problem 2.	(24 points possible)
_____	Problem 3.	(20 points possible)
_____	Problem 4.	(20 points possible)
_____	Problem 5.	(12 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. (24 points)

(a) (6) State two reasons why perceived risk may be viewed as less than actual risk.

(b) (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 _____

(c) (6) A piece of equipment with an 8-year life has a payment schedule of 9 equal annual payment of \$3,000 each, the first payment occurring immediately. We wish to convert this set of payments to an equivalent series of 8 annualized payments, the first payment occurring one year from the present. Determine the amount of each new payment and the present value of the entire series. The interest rate appropriate to the calculation is 6%. Show all calculations.

Each payment _____

Present value of series _____

(d) (6) 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 _____

Problem 2. (24 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 by 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 survive past 300 hours of their life? **a b c d**
(a) 238 (c) 1554
(b) 446 (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 60%. While producing 1000 good units, approximately how many total inspections will have to be performed? **a b c d**
(a) 400 (c) 1,400
(b) 1,000 (d) 2,800
- E. Two of the four types of capital, as defined relating to sustainability, are **a b c d**
(a) human capital and natural capital
(b) management capital and financial capital
(c) natural capital and intellectual capital
(d) sustainable and non-sustainable capital
- F. While performing a benefit-cost analysis of a proposed new highway, an engineer must determine whether to treat periodic resurfacing costs as a deferred cost or as a disbenefit. 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 machines are involved in producing a part for a printed circuit board. a b c d e
 For a batch of 10000 boards, 4000 of the boards have the part made by machine A, and 6000 have the part made by machine B. Machine A has a defect rate of 2 %, and machine B has a defect rate of 6%. If a board is randomly selected after the part has been inserted, and it is determined that the part is defective, what may one conclude?

- (a) The probability that machine A made the part is 40%, and the probability that Machine B made the part is greater than 60%
- (b) The probability that machine A made the part is 40%, and the probability that Machine B made the part is 60%
- (c) The probability that machine A made the part is greater than 40%, and the probability that Machine B made the part is less than 60%
- (d) The probability that machine A made the part is less than 40%, and the probability that Machine B made the part is greater than 60%
- (e) The probability that machine A made the part is greater than 40%, and the probability that Machine B made the part is 60%

Problem 3. (20 points)

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

$C_p = 1.5$ $C_{pk} = 1.2$ Target mean = 420 Actual mean = 460

Assume design specifications are symmetric around the target mean and 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.

- Lower specification limit: _____
- Upper specification limit: _____
- Standard deviation: _____
- Defects below LSL
(in terms of tail-end Z function): _____
- Defects above USL
(in terms of tail-end Z function): _____

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.

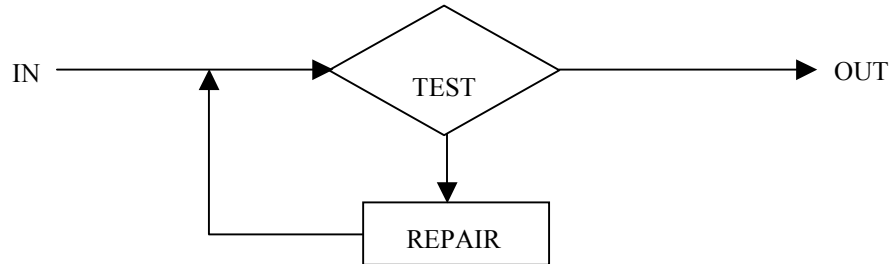
- | | | |
|---|-------------|---------------|
| (a) The failure of the walkways in the Hyatt Regency hotel was primarily the result of errors in the original design specifications. | TRUE | FALSE |
| (b) The doctrine of strict liability usually provides a more difficult standard for a plaintiff to achieve than does the proof of negligence in order that a corporation be held legally liable for harm caused by a product. | TRUE | FALSE |
| (c) It is possible to obtain a patent without a working model. | 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) On the morning portion of the Fundamentals of Engineering Exam, one may select either a discipline-specific exam or a general engineering exam. | 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 constant per-unit failure rate, then its reliability function is constant with time. | 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) Most government standards for products are stated in the form of design standards, as opposed to performance standards. | 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. (12 points)

A manufacturing process with a test station is characterized by an average of 1.2 defects per unit. Assume perfect repair and perfect coverage.



(a)(5 points) How many total tests must be performed to produce 10,000 defect-free units out?

(b)(5 points) How many of the 10,000 defect-free units produced had less than three tests applied to them?

(c)(2 points) How many of the 10,000 defect-free units produced had three or more tests applied to them?
