

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.	(24 points possible)
_____	Problem 2.	(20 points possible)
_____	Problem 3.	(21 points possible)
_____	Problem 4.	(20 points possible)
_____	Problem 5.	(15 points possible)
_____	<b>TOTAL.</b>	(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) Are most government standards written in the form of design standards or performance standards? State a reason.

Design    or    Performance (circle one)

Reason \_\_\_\_\_

(b) (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 \$350,000. 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) than if the maintenance were treated as a cost?

Justification \_\_\_\_\_

Larger    or    Smaller (circle one)

(c) (6) State a reason why some countries might choose not to implement public policies normally associated with the achievement of a sustainable society?

Reason \_\_\_\_\_

\_\_\_\_\_

(d) (6) State two general classes of intellectual property

\_\_\_\_\_

\_\_\_\_\_

**Problem 2. (20 points)**

- (a) (12) A piece of equipment with an 8-year life has a payment schedule of 8 equal annual payment of \$3,000 each, the first payment occurring one year from the present. We wish to convert this set of payments to an equivalent annual series of 8 arithmetically increasing payments, the first payment of \$2,000 occurring also one year from the present. Determine the present value of the entire series and the amount of the second payment. The interest rate appropriate to the calculation is 8%. Show all calculations.

Present value of series \_\_\_\_\_

Second payment \_\_\_\_\_

- (b) (8) We now wish to convert the above set of payments to an equivalent annual series of 9 equal annual payments, the first payment occurring immediately. Determine the amount of each payment. The interest rate appropriate to the calculation is the same, 8%. Show all calculations.

Each payment \_\_\_\_\_

**Problem 3. (21 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 600 hours. The process is characterized by two sub-systems with parallel reliabilities of 0.2 and 0.6 at 200 hours. Determine the number of these devices that have survived past 200 hours of their life? **a b c d**  
(a) 1500 (c) 6800  
(b) 3200 (d) 8500
- 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  $4 \times 10^{-3} \text{ hr}^{-1}$ . How many of these devices have failed before 200 hours of their life? **a b c d**  
(a) 238 (c) 1204  
(b) 602 (d) 1398
- C. A manufacturing process has an average defect rate of 1.5 defects per unit. What is the probability that a particular unit will have greater than two defects? **a b c d**  
(a) 19.1 % (c) 44.2 %  
(b) 25.1 % (d) 74.9 %
- D. A manufacturing process step, involving inspection with perfect repair and 100% coverage, has a first-time yield (FTY) of 80%. While producing 2,000 good units, approximately how many total inspections will have to be performed? **a b c d**  
(a) 1,600 (c) 3,200  
(b) 2,400 (d) 3,600
- 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 levy for a city, 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 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

**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) Assuming that the initial payment of a series of 10 annual payments is \$200, then a geometric series of payment increasing 6% a year has necessarily a higher present value than an arithmetic series increasing \$12 per year for any non-zero, positive interest rate. | <b>TRUE</b> | <b>FALSE</b> |
| (b) Under the doctrine of strict liability, negligence does not have to be proved before a corporation is legally liable.   | <b>TRUE</b> | <b>FALSE</b> |
| (c) A patent application by a company must disclose enough information for the idea to be duplicated easily by all other companies.   | <b>TRUE</b> | <b>FALSE</b> |
| (d) An advantage of experiment-based design compared to theoretical-based design is that experiment-based design provides a more realistic representation of manufacturing variations.  | <b>TRUE</b> | <b>FALSE</b> |
| (e) Professional engineers are licensed by the US government and may legally practice in all 50 states.   | <b>TRUE</b> | <b>FALSE</b> |
| (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.  | <b>TRUE</b> | <b>FALSE</b> |
| (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.   | <b>TRUE</b> | <b>FALSE</b> |
| (h) The perceived risk is typically less than the actual risk if the consequences are in the future.  | <b>TRUE</b> | <b>FALSE</b> |
| (i) A definition of the term “ukase” is a regulatory ruling with the force of law.  | <b>TRUE</b> | <b>FALSE</b> |
| (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.  | <b>TRUE</b> | <b>FALSE</b> |

**Scoring:**        \_\_\_\_\_ correct answers x 2pts =        \_\_\_\_\_  
                              minus number of incorrect answers    –        \_\_\_\_\_

Score:

**Problem 5. (15 points)**

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

$$C_p = 1.6 \quad C_{pk} = 1.2 \quad \text{Target mean} = 480 \quad \text{Actual mean} = 440$$

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, assuming 10,000 units. You must show your calculations in the space below in order to receive full credit.

Lower specification limit: \_\_\_\_\_

Upper specification limit: \_\_\_\_\_

Standard deviation: \_\_\_\_\_

Number of defective units  
below LSL: \_\_\_\_\_

Number of defective units  
above USL: \_\_\_\_\_