Problem 1.

(a) Most government standards are written as design standards, because they are easier to regulate and enforce.

(b) Maintenance expenses, as do most public benefits, occur over a period of time, so may be more appropriate to treat them as a disbenefit, as opposed to a cost, which typically occurs at the beginning or construction phase of a project. If a small additional item exists that could be classified as either a disbenefit or as an additional cost, classification as a disbenefit would result in a higher benefit-cost ratio. This can be proved algebraically, or can be verified by direct observation, e.g., that (100-10)/80> 100/(80+10).

(c) One definition of sustainability is to do no harm to future generations. One fundamental problem with the implementation of public policy to achieve this worthy goal is that no one really knows how to achieve it, The implementation may prove very expensive and involve regulation that may interfere with the operation of a free market economy, causing market inefficiencies.

(d) Four general classes of intellectual property are: patents, copyrights, trademarks, and trade secrets.

Problem 2.

(a) The present value of a series of 8 annual payments of amount A_1, the first occurring one year from the present, at an interest rate of 8% is

$P=A_1(P/A,8\%,8)=A_1(5.7466)$

Version #1

$P=3{,}000(5.7466)= \$17{,}240$

$P=2{,}000\ (P/A,8\%,8) + G(P/G,8\%,8)$

$17{,}240=2{,}000(5.7466) + G(17.8061)$

$G=322.73$

Second payment=2,000 + G=\$2,323

(b) For 9 equal annual payments of amount A_1, the first occurring immediately, at an interest rate of 6%, the present value is:

$P=A_1+ A_1\ (P/A,8\%,8)=17{,}240$

$A_1=17{,}240/6.7466 =\$2{,}555$

Name:_______________________________________ Student #:___________________________

Version #2

P=4,000(5.7466)= \$22,986

This present value is also equal to that of the gradient series.

P=3,000 (P/A,8%,8) + G(P/G,8%,8)

22,986=3,000(5.7466) + G(17.8061)

G=322.73

Second payment=3,000 + G=\$3,323

(b) For 9 equal annual payments of amount A_1, the first occurring immediately, at an interest rate of 6%, the present value is:

$P=A_1+ A_1$ (P/A,8%,8)=22,986

A_1=22,986/6.7466 =\$3,407

Problem 3

A. 10,000 devices are being tested for 600 hours. The process is characterized by two sub-systems with parallel reliabilities of .2 and .6 at 200 hours. The number of devices that survive past 200 hours may be determined from the reliability at 200 hours: R=1-(1-R1)(1-R2)=.68. # of survivors at 200 hours= 10,000(.68)=6800. (c)

B. A group of 2,000 devices is characterized by two sub-systems with series reliabilities and per unit failure rates of 2.0×10^{-3} hr^{-1} and 4.0×10^{-3} hr^{-1}. The overall per unit failure rate is 2.0×10^{-3} hr^{-1} + 4.0×10^{-3} hr^{-1}= 6.0×10^{-3} hr^{-1}. The number of devices that survive past 200 hours of their life=# of survivors at 200 hours= $2{,}000(e^{-(.006)(200)})$=602. The number that heave failed=2,000-602=1,398. (d)

C. A manufacturing process has an average defect rate of 1.5 defects per unit. The probability that a particular unit will have greater than 2 defects is equal to one minus (the probability that a unit have zero plus the probability that a unit have exactly one defect, plus the probability that a unit have exactly 2 defects). Prob { k defects} = $(dpu^{k} / k!)\ e^{-dpu}$; Prob { 0 defects } = $(dpu^{0} / 0!)\ e^{-dpu}$ = .2231.
Prob { 1 defect} = $(dpu^{1} / 1!)\ e^{-dpu}$.=.3347; Prob. {2 defects} =$(dpu^{2} / 2!)\ e^{-dpu}$ =.2510
Prob(>2)=1-.8088=19.1% (a)

D. A manufacturing process step, involving inspection with perfect repair and 100% coverage, has a first-time yield of 80%. **Version #1**: For a FTY of .80, while producing 2000 good units, the number of total inspections that will have to be performed is equal to 1 x 1600 +2 x (2000-1600) = 2,400 (b)
Version #2: For a FTY of .80, while producing 3000 good units, the number of total inspections that will have to be performed is equal to 1 x 2400 +2 x (3000-2400) = 3,600 (d)

E. The four types of capital that were defined in relation to sustainability are: human, financial, manufactured, and natural. (a)

F. The decision on what dollar amount to assign to represent the effect of the change in residents' view because of the height of the earthworks is representative of the quantification of an intangible item. (a)

G. Most engineering disasters are a result of a rare combination of unexpected events. (a)

Name: ______________________ Student #: ______________________

Problem 4.

(a) If the initial payment of a geometric gradient series is $200, and the gradient corresponds to 8%, then the second payment is increased by $16 over the first, but each subsequent payment increases by more than $16. Each of the last 8 terms of the geometric series is therefore greater than each of the corresponding terms of the arithmetic series, so entire geometric series has a higher present value. **(Version #1-geometric higher) TRUE**
(Version #2-geometric lower) FALSE

(b) Under the doctrine of strict liability, negligence does not have to be proved before a corporation is legally liable. All that must be shown is that the product was defective and unreasonably dangerous, the defect existed when the product left the defendant's control, the defect caused the harm, and the harm is appropriately assignable to the defect. The intent of the defendant is not the issue. This is an easier standard for a plaintiff to prove. **TRUE**

(c) To obtain a patent, one must include a "preferred embodiment" in sufficient detail that one of ordinary skill in the art could make your embodiment. Not all companies possess "ordinary skill in the art." **FALSE**

(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. Other advantages are that experiment-based design handles complex interactions, prevents over-design (not necessary to handle worst–case), minimizes the probability that something random produces a defect. **TRUE**

(e) **(Version #1)** Professional engineer's licensure is granted by the individual states, and in some disciplines there are differing requirements among the states. **FALSE**
(Version #2) Refer to (h) below. **TRUE**

(f) **(Version #1)** If a company has complied with ISO 9000:2000 standards, it means that the organization haa adopted procedures, practices, and standards for a quality system capable of meeting customer requirements, not that those customer requirements have necessarily been met. **FALSE**
(Version #2) Refer to (i) below. **TRUE**

(g) **(Version #1)** If the reliability of device can be characterized by a constant per-unit failure rate, then the reliability function may be expressed as $R=e^{-\lambda t}$, a decreasing function of time. **FALSE**
(Version #2) Refer to (j) below. **TRUE**

(h) **(Version #1)** There is typically higher tolerance for risk (perceived risk less than actual risk) if the action is voluntary and familiar; the consequences are in the future; one is in control; people affected are different from the assessor; and the institution causing the risk is not a corporation or a government agency. **TRUE**
(Version #2) Refer to (e) above. **FALSE**

(i) **(Version #1)** A definition of the term "ukase" is a regulatory ruling with the force of law. **TRUE**
(Version #2) Refer to (f) above. **FALSE**

(j) **(Version #1)** Both the ABET code and the NCEES code emphasize the public safety and welfare, and are quite similar. **TRUE**
(Version #2) Refer to (g) above. **FALSE**

Name:____ Student #:____________________________

Problem 5.

A manufacturing process is characterized by the following values:

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

The design specifications are symmetric around the target mean, and the characteristics of the manufactured item are distributed according to a normal (Gaussian) distribution.

Cpk = Cp (1 – k)

1.2=1.6(1-k)

k=.25

k = | Actual Mean – Target Mean | / ((USL – LSL) / 2)

.25= | 440– 480 | / ((USL – LSL) / 2)

USL – LSL=320

USL= Upper specification limit=640 LSL= Lower specification limit=320

Cp = (USL – LSL) / (6 sigma)

1.6=320 / (6 sigma) 6 sigma=200

Standard deviation=sigma= 33.33

Defects below LSL=10,000Z((440-320)/33.33)=10,000Z(3.6)=10,000 (.000159)
Defects below LSL=2

Defects above USL=10,000Z((640-40)/33.33)=10,000Z(6)=10,000 ($9.9x10^{-10}$)
Defects above LSL=0