Problem 1.

(a) There is typically higher tolerance for risk (perceived risk less than actual risk) if:

Voluntary
Familiar
In the future
One is in control
People affected are different from the assessor
Institution causing the risk is not a corporation or a government agency

(b) The disadvantage of performing a single long simulation instead of several intermediate length simulations is that randomness at early times may give a false impression of the nature of the process. One may never see the "average."

The disadvantage of performing many short simulations is that one may never see the trend, or "big picture", but may only see what appears to be noise in the pattern.

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

$$P=A_1+ A_1 (P/A,6\%,8)$$

$$P=3{,}000(1+6.2098)=\$21{,}629$$

For the new series of 8 equal annual payments of amount A_2, the first occurring one year from the present, at an interest rate of 6%, the present value is:

$$P=A_2(P/A,6\%,8)=\$21{,}629$$

Therefore, $A_2=\$21{,}629/(P/A,6\%,8)=\$21{,}629/6.2098=\$3{,}483.$

(d) The benefit-cost ratio is usually used instead of the benefit-cost difference in order to account for projects of different scale. Two large numbers can have a seemingly large difference, even though the fractional difference is small.

Problem 2

A. 10,000 devices are being tested for 500 hours. The process is characterized by two sub-systems with parallel reliabilities of .3 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)=.72. # of survivors at 200 hours= 10,000(.72)=7200. The number that heave failed=10,000-7,200=2,800. (a)

B. A group of 2,000 devices is characterized by two sub-systems with series reliabilities and per unit failure rates of $2.0 \times 10^{-3}\ hr^{-1}$ and $3.0 \times 10^{-3}\ hr^{-1}$. The overall per unit failure rate is $2.0 \times 10^{-3}\ hr^{-1} + 3.0 \times 10^{-3}\ hr^{-1}=$ $5.0 \times 10^{-3}\ hr^{-1}$.The number of devices that survive past 300 hours of their life=# of survivors at 300 hours= $2{,}000(e^{-(.005)(300)})$=446 (b)

C. A manufacturing process has an average defect rate of 1.6 defects per unit. The probability that a particular unit will have less than 3 defects is equal to 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 } = $(dpu^{0} / 0!)\, e^{-dpu}$ = .2019 Prob { 1 defect} = $(dpu^{1} / 1!)\, e^{-dpu}$.=.3230 Prob. {2 defects} =$(dpu^{2} / 2!)\, e^{-dpu}$ =.2584 Prob(<3)=.7833=78.3% (d)

D. A manufacturing process step, involving inspection with perfect repair and 100% coverage, has a first-time yield of 60%. For a FT

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

F. The decision on whether to treat periodic resurfacing costs as a deferred cost or as a disbenefit is representative of the classification of a tangible item. (c)

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

H. Two machine produce printed circuit boards, with 40 % made by machine A, and 60% by machine B. Machine B has the higher defect rate. If a randomly selected board is defective, then we know by Bayes' theorem that there is a probability lower than 40% that A made the board and a probability higher than 60% that B made the board (d)

Problem 3.

A manufacturing process is characterized by the following values:

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

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=1.5(1-k)

k=.2

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

.2= | 460– 420 | / ((USL – LSL) / 2)

USL – LSL=400

USL= Upper specification limit=620 LSL= Lower specification limit=220

Cp = (USL – LSL) / (6 sigma)

1.5=400 / (6 sigma) 9 sigma=400

Standard deviation=sigma= 44.44

Defects below LSL=Z((460-220)/44.44)=Z(5.4)
(in terms of tail-end Z function):

Defects above USL=Z((620-460)/44.44)=Z(3.6)
(in terms of tail-end Z function):

Problem 4.

(a) **(Version #1)** The Hyatt walkway was not constructed in accordance with the original design specifications. **FALSE**
(Version #2) Refer to (i) below. **TRUE**

(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. **FALSE**
(Version #2) Refer to (a) above. **FALSE**

(c) **(Version #1)** It is possible to obtain a patent without a working model. One must include a "preferred embodiment" in sufficient detail that one of ordinary skill in the art could make your embodiment. **TRUE**
(Version #2) Refer to (b) above. **FALSE**

(d) **(Version #1)** A product whose design is based on worst case analysis is typically more expensive. **TRUE**
(Version #2) Refer to (c) above. **TRUE**

(e) **(Version #1)**The morning portion of the Fundamentals of Engineering Exam is a general examination. There is not an option to select a discipline-specific exam in the morning. **FALSE**
(Version #2) Refer to (d) above. **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 (e) above. **FALSE**

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

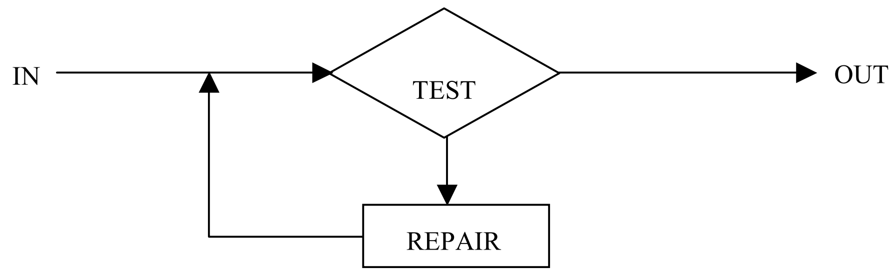
(h) **(Version #1)** The roof-top portion of the QFD diagram describes the trade-off among the engineering requirements. The trade-off between the consumer desires and the engineering requirements occurs in the main rectangular section of the diagram. **FALSE**
(Version #2) Refer to (g) above. **FALSE**

(i) Most government standards are written as design standards, as opposed to perfomance standards,because they are easier to regulate and enforce. **TRUE**.
(Version #2) Refer to (h) above. **FALSE**

(j) Both the ABET code and the NCEES code emphasize the public safety and welfare, and are quite similar. **TRUE**

Problem 5.

A manufacturing process with a test station is characterized by an average of (**version #1**, 1.2, **version #2**, 1.4) defects per unit. Assume perfect repair and perfect coverage.



(a) The total number of tests that must be performed to produce 10,000 defect-free units out is equal to:

10,000(1+ dpu) = 22,000 **(version #1)**
24,000 **(version #2)**

(b) The number of the 10,000 defect–free units produced that had less than three tests applied to them =

number that had one test + number that had two tests=10,000 P(0) + 10,000 P(1).

Version #1:

P(0)= Prob { 0 defects } = $(dpu^{0} / 0!)\, e^{-dpu}$ = .3012 Prob { 1 defect} = $(dpu^{1} / 1!)\, e^{-dpu}$.=.3614

10,000 (.3012+.3614) = 6626

Version #2:

P(0)= Prob { 0 defects } = $(dpu^{0} / 0!)\, e^{-dpu}$ = .2466 Prob { 1 defect} = $(dpu^{1} / 1!)\, e^{-dpu}$.=.3452

10,000 (.2466+.3452) = 5918

(c) The number of the 10,000 defect–free units produced that had three or more tests applied to them is equal to

Version #1: 10,000-(answer to part b)= 10000-6626= 3374

Version #2: 10,000-(answer to part b)= 10000-5918= 4082