Problem 1.

(a) There is typically higher tolerance for risk if:

Voluntary
Familiar
Uncertain
In the future
One is in control

Tolerance depends on who is affected.
Tolerance depends on the institution causing the risk.

(b) 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.

(c) 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.

(d) The advantages of performing experiment-based design are :

Provides more realistic representation of manufacturing variations
Handles complex interactions
Prevents over-design (not necessary to handle worst–case
Minimizes probability that something random produces a defect

The disadvantages of performing experiment-based design are:

May determine a local instead of a global optimization
Assumes smooth response.

Problem 2.

A manufacturing process is characterized by the following values:

Cp=8
Cpk = .752
USL=3.6×10^{-6}
LSL=1.2×10^{-6}

The characteristics of the manufactured item are distributed according to a normal (Gaussian) distribution.

Cp = (USL – LSL) / (6 sigma)=$(3.6-1.2) \times 10^{-6}$ /(6 sigma)= .8

Sigma = 5×10^{-7} ohms

Cpk = Cp (1 – k) .752=.8(1-k)

k = .06 = | Actual Mean – Target Mean | / ((USL – LSL) / 2)

(USL-LSL)= 2.4×10^{-6}

| Actual Mean – Target Mean | = .072 x 10^{-6}

Fractional shift=.072 x 10^{-6} /AM =.03

Defects below LSL = Z((2.472-1.2)/.5)=Z(2.544)
(in terms of tail-end Z function) (for AM>TM)

Defects above USL = Z((3.6-2.472)/.5)=Z(2.256)
(in terms of tail-end Z function) (for AM>TM)

Note: If AM<TM, answers for defects will be reversed.

Problem 3

A. 10,000 devices are being tested for 500 hours. The process is characterized by series reliabilities with per unit failure rates of 3×10^{-3} hr^{-1} and 1×10^{-3} hr^{-1}. The number of devices that survive past 400 hours of their life=# of survivors at 400 hours=10,000 $e^{-(.004)(400)}$ =2019 (a)

B. A similar group of 10,000 devices with same per unit failure rates, but parallel reliabilities are being tested. The number of devices that survive past 400 hours of their life=# of survivors at 400 hours= 10,000(1-$e^{-(.003)(400)}$)(1-$e^{-(.001)(400)}$)=7696 (d)

C. A manufacturing process has an average defect rate of 1.8 defects per unit. The probability that a particular unit will have less than 2 defects is equal to the number that have zero plus the number that have exactly one defect.
Prob { k defects} = (dpu^k / k!) e^{-dpu} ; Prob { 0 defects } = (dpu^0 / 0!) e^{-dpu} = .1653
Prob { 1 defect} = (dpu^1 / 1!) e^{-dpu}.=.2975
Prob. of less than 2=.1653+.2975=.4628=46.3% (b)

D. A manufacturing process step, involving inspection with perfect repair and 100% coverage, has a first-time yield (FTY) of (version #1, 65%, version #2, 35%). For a FTY of .65. While producing 1000 good units the number of total inspections that will have to be performed is equal to (2-FTY)1000 = version #1 1,350 (b), version #2 1,650 (d)

E. A manufacturing line produce microprocessors whose average maximum operating clock speed is 160 MHz. Assuming a normal distribution of maximum operating speeds and a standard deviation of 30MHz, the percentage of microprocessors that will operate correctly at 124 MHz is 1-Z((160-124)/30))=1-.115=.885=88.5% (c)

F. A system composed of two parallel subsystems of reliability (version #1, .4 and .6, version #2, .2 and.4) respectively, has a system reliability of R=1-(1-R1)(1-R2)=[version#1 1-(.6)(.4)=.76 (c)])=[version#2 1-(.8)(.6)=.52 (b)]

G. The Stancell Leadership Module discusses that the characteristics of a servant leader requires commitment to the organization and its members, having vision and integrity, and a willingness to delegate and empower others. Ability to develop and implement a complex organizational plan is not specifically mentioned. (c)

H. The decision on the dollar amount to assign to represent the perception of increased safety is representative of the quantification of an intangible idea. (a)

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

J. Two resistors are wired together in series, R=R1+R2. R1 has a value of 1 Kilohm, with a tolerance of 2%. This corresponds to a minimum value of .98, and a maximum value of 1.02. R2 has a value of 2 Kilohm, with a tolerance of 3%. This corresponds to a minimum value of 1.94, and a maximum value of 2.06. The equivalence therefore has a minimum value of 2.92, and a maximum value of 3.08. This corresponds to 3 Kilohms, with a tolerance of 2.7% (b)

Problem 4.

(a) The Hyatt walkway was not constructed in accordance with the original design specifications. **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) (Version #1) A definition of the term "ukase" is a regulatory ruling with the force of law. **TRUE**
(Version #2) Refer to (e) below. **FALSE**

(d) 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. **FALSE**

(e) (Version #1)The morning portion of the Fundamentals of Engineering Exam is a general examination and does include questions on both ethics and engineering economy. **FALSE**
(Version #2) Refer to (c) above. **TRUE**

(f) 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**

(g) The infant mortality region of the "bathtub" model of device reliability is typically characterized by a decreasing per-unit failure rate. **TRUE**

(h) 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**

(i) The decision to classify a tangible factor in a benefit-cost analysis. It is difficult to determine a numerical value, but it nearly always has to be done. **TRUE**

(j) Most government standards are stated in the form of design standarsds, as opposed to performance standards. **TRUE**

Problem 5.

A company is making a decision on which of three possible alternatives to design and build. A decision theory model for the preojected revenue is to be used (dollar amounts are in millions). An interest rate of 6%, and a lifetime of 8 years is appropriate. Using an equivalent **annualized value** viewpoint, the annualized value of expected revenue of each alternative is:

Alternative #1 expected revenue (annualized value) =
.8(2100)+.2[(1000+5000)/2]=$2,280

Alternative #2 expected revenue (annualized value) =

.7(2100)+.3[(4000+0)/2]=$2,630

Alternative #3 expected revenue (annualized value) =

2000+2000(A/P, 6%, 5)=$2,322

Note: The expected revenue from Alternative # 1 is overestimated, since the larger amount of the two year cycle occurs in the second year, and the expected revenue from Alternative # 2 is underestimated, since the larger amount of the two year cycle occurs in the first year. An exact calculation would therefore necessarily still yield the same choice. An exact calculation could be performed by converting each cash flow, term by term, to the present and then annualizing the sum, or by annualizing each future flow, and then summing the annual amounts.

Choose alternative # 2