Problem 1.

(a) The disadvantage of performing a single long simulation of a system instead of several intermediate length simulations is that the dependence of the simulation on the randomness at early times may give a false impression of the nature of the process. The disadvantage of many short simulations is that a trend, or final condition, may not have time to emerge. One may be simulating the transient start –up only.

(b) Recycling might not be economically feasible because the mixed material components may be difficult to separate, and also the material, when separated, may not be worth enough to justify the separation expense.

(c) Besides hitting the iceberg, there are several factors that contributed to the large loss of life in the sinking of the Titanic. The prevailing view was that the ship was unsinkable, and so an insufficient number of lifeboats were available. The design of the ship was such that if one compartment in the ship filled with water, then the ship tipped, and the adjoining compartment would fill, thereby causing further tipping.

(d) The sentence "The car, which was travelling 60 miles per hour, is red." Means that there is only one car, it is red, and it incidentally happens to be traveling 60 miles per hour. The sentence," The car that was travelling 60 miles per hour is red" means that there is more than one car and the one that is travelling 60 miles per hour is the red one.

Problem 2.

Assume that an engineer has determined the benefit-cost ratio of a project to be 2.0. 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 3.9/2 > 4/2.1

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 3.

A manufacturing process is characterized by the following values:

$C_p = 3.0$ $C_{pk} = 2.4$ Target mean = 800 Actual mean = 860

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

Cpk = Cp (1 – k) => 2.4 = 3.0 (1 – k) => 0.8 = 1 – k => k = 0.2

k = | Actual Mean – Target Mean | / ((USL – LSL) / 2)
0.2 = | 860– 800 | / ((USL – LSL) / 2)
USL – LSL = 600
USL = Upper specification limit=1100
LSL = Lower specification limit=500

Cp = (USL – LSL) / (6 sigma)
3.0 = 600 / (6 sigma)
6 sigma = 200
Standard deviation = sigma = 33.33

Defects below LSL = Z((860-500)/33.33) = Z(10.8) (in terms of tail-end Z function)
Defects above USL = Z((1100-860)/33.33) = Z(7.2) (in terms of tail-end Z function)

Name:____ Student #:______________________________

Problem 4

A. 10,000 devices are being tested for 300 hours. The process is characterized by a per unit failure rate of $4x10^{-3}$ hr^{-1}. The number of devices that do not survive past 300 hours of their life = 10,000-# of survivors = 10,000-10,000 $e^{-(.004)(300)}$ = 10,000-3012 = 6988 **(d)**

B. A manufacturing process has an average defect rate of 1.8 defects per unit. The probability that a particular unit will have less than 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)**

C. A manufacturing process step, involving inspection with perfect repair and 100% coverage, has a first-time yield (FTY) of 30.1%. While producing 1000 good units the number of total inspections will have to be performed is equal to 1(FTY)1000 + 2(1-FTY)1000=1(301)+2(699)=1,699 **(c)**

D. A manufacturing line produce microprocessors whose average maximum operating clock speed is 150 MHz. Assuming a normal distribution of maximum operating speeds and a standard deviation of 30MHz, the percentage of microprocessors that will operate correctly at 120 MHz is 1-Z((150-120)/30))=1-.16=.84=84% **(d)**

E. A system composed of two parallel subsystems of reliability .6 and .8 respectively, has a system reliability of R=1-(1-R1)(1-R2)=1-(.4)(.2)=.92 **(c)**

F. A semiconductor manufacturing company owns the assets listed: copyright on a textbook on integrated circuits specially purchased oven for making the masks, patent on the integrated circuit manufacturing process, and trademark of the company logo. The one that is not a form of intellectual property is the specially purchased oven for making the masks. **(b)**

Problem 5.

(a) Professional engineers are licensed by the individual state governments and may not legally practice in all 50 states. **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. **TRUE**

(c) Most government standards for products are stated in the form of design standards, as opposed to performance standards. **FALSE**

(d) The annotated bibliography is not supposed to be included as part of the formal research paper. The formal research paper has a set of references, to which are referred in the body of the paper. **TRUE**

(e) It has not been determined that a no-growth policy is necessary to elevate overall living standards. No conclusive approach to the elevation of living standards consistent with achieving a sustainable society has been demonstrated. Significant counter-examples are in abundance. Most would agree that the United states has a higher living standard than that of a century ago, particularly in the areas of medical and dental care, yet we have experienced tremendous growth. **FALSE**

(f) The perceived risk is typically less than the actual risk if the consequences are in the future, such as smoking. **TRUE**

(g) The useful lifetime region of the “bathtub” model of device reliability is typically characterized by a constant, or slightly increasing, per-unit failure rate. **FALSE**

(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) It is possible to include intangible factors in a numerical benefit-cost analysis. It is difficult to determine a numerical value, but it nearly always has to be done. **TRUE**

(j) A system composed of two subsystems in parallel is always more reliable than a system composed of the same two subsystems in series, assuming that for each subsystem, $0<R<1$.
$R=1-(1-R1)(1-R2)=R1+R2-R1R2=R!+R2(1-R!)>R1$, for $0<R1,R2<1$. **TRUE**

Problem 6.

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). All systems cost the same. An interest rate of 6% is appropriate. Using an equivalent **present value** viewpoint, the present value of expected revenue of each alternative is:

Alternative #1 expected revenue (present value) =
.8(400)+.2(600)=$440

Alternative #2 expected revenue (present value) =
100+100(P/A. 6%,4) =$447

Alternative #3 expected revenue (present value) =
105(P/A. 6%,5)=$442

Choose alternative # 2