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) 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.

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

Problem 2.

Version #1

(a) The first payment in an arithmetic gradient series of 8 payments is $1,200, and the last payment is $3,300, and the interest rate appropriate to the calculation is 8%. The gradient is determined from:

$A_8 = A_1 + 7G$
$3300 = 1200 + 7G$
$G = 300$

The present value of the gradient series of 8 annual payments, beginning with a first payment of 1,200, with an arithmetic gradient increase of 300 is:

$$P=1{,}200\,(P/A,8\%,8) + 300(P/G,8\%,8)$$

$$P=1{,}200(5.7466) + 300\,(17.8061)$$

$$P= 12{,}238$$

(b) The last payment in a geometrical gradient series of 8 payments is $1,800. Each payment increases by 4% over the preceding payment, and the interest rate appropriate to the calculation is 8%.

If F_1 is the first payment in a geometric series and F_n the nth payment, then

$$F_n = F_1(1+i)^{n-1},\ F_1 = F_n(1+i)^{-n+1},\ F_1 = 1{,}800(1+.04)^{-7},\ F_1=\$1367.85$$

The present value of the entire series is

$$P= F_1(P/F_1,g,i,n)=1367.85(P/F_1,4\%,8\%,8)=1367.85\,(6.5151)=\$8{,}912$$

(c) For 8 equal annual payments of amount 2,000, the first occurring one year from the present, at an interest rate of 8%, the present value is:

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

For 9 equal annual payments of amount A_1, the first occurring immediately, at an interest rate of 8%, the present value is:

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

$$A_1+ A_1\ (P/A,8\%,8) = 2{,}000\ (P/A,8\%,8)$$

$$A_1= (2{,}000)(5.7466)/6.7466 =\$1{,}704$$

Version #2

(a) The first payment in an arithmetic gradient series of 8 payments is $1,200, and the last payment is $4,000, and the interest rate appropriate to the calculation is 8%.

$$A_8 = A_1+7G$$
$$4000= 1200+7G$$
$$G=400$$

The present value of the gradient series of 8 annual payments, beginning with a first payment of 1,200, with an arithmetic gradient increase of 300 is:

$$P=1{,}200\ (P/A,8\%,8) + 400(P/G,8\%,8)$$

$$P=1{,}200(5.7466) + 400\ (17.8061)$$

$$P= 14{,}018$$

(b) See part (b) above

(c) Same as part (c) above, except payments are $4,000.

$$A_1= (4{,}000)(5.7466)/6.7466 =\$3{,}407$$

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 .4 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)=.52. # of survivors at 200 hours= 10,000(.52)=5200. The number that have failed = 10,000-5200 =4800. (c)

B. A group of 3,000 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= $3{,}000(e^{-(.006)(200)})$=904. (b)

C. A manufacturing process has an average defect rate of 1.6 defects per unit. The probability that a particular unit will have greater than one defect is equal to one minus (the probability that a unit have zero plus the probability that a unit have exactly one defect). 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(>1)=1-.5249=47.5% **Version #1** (c) **Version #2** (b)

D. **Version #1**: A manufacturing process step, involving inspection with perfect repair and 100% coverage, has a first-time yield of 30.1%. For a FTY of .301, e^{-dpu} = .301; dpu=1.2006. While producing 2000 good units, the number of total tests that will have to be performed is equal to 2,000(1 + 1.2006) = 4,401 (c)

Version #2: A manufacturing process step, involving inspection with perfect repair and 100% coverage, has a first-time yield of 49.7%. For a FTY of .301, e^{-dpu} = .497; dpu=0.6992. While producing 2000 good units, the number of total tests that will have to be performed is equal to 2,000(1 + 1.6992) = 3,398 (b)

E. R =R1 + R2. R1 has a value of 2 Kilohms, with a tolerance of 2.0%, and R2 has a value of 3 Kilohms, with a tolerance of 3.0%. The equivalence has a mean value of 2 + 3 = 5 kilohms. Since the tolerance represents absolute upper and lower values, the upper value for R is 5 + .04 + .09=5.13. Similarly, the lower value is 5-.13, or the equivalence is R=5, with a tolerance of 2.6% (a)

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

Problem 4.

(a) The Hyatt walkway was not constructed in accordance with the original design specifications. **FALSE**

(b) **(Version #1)** 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**
(Version #2) Refer to (c) below. **FALSE**

(c) **(Version #1)** Most government standards are written as design standards, as opposed to performance standards, because design standards are easier to regulate and enforce. **FALSE**.
(Version #2) Refer to (d) below. **TRUE**

(d) **(Version #1)** A potential advantage of building a prototype compared to performing a simulation is that it is easier to discover unforeseen interactions among the system components. Another advantage is that a prototype may prove useful in marketing. The disadvantage of building prototypes is that it may be time-consuming and expensive. It is difficult to do many cases with prototype-.based design. **TRUE**
(Version #2) Refer to (e) below. **TRUE**

(e) **(Version #1)** There are seven options for the afternoon portion of the Fundamentals of Engineering examination: chemical. civil, electrical, environmental, industrial, mechanical, and other/general.**TRUE**
(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 two parallel reliabilities with two constant per-unit failure rates, then the reliability function still may not be expressed as $R=e^{-\lambda t}$, which would be required for a constant overall per-unit failure rate. **FALSE**
(Version #2) Refer to (b) above. **TRUE**

(h) The morning portion of the Fundamentals of Engineering Exam is a general examination and does include questions on both ethics and engineering economy. **FALSE**

(i) The Baldridge Award is typically given to an organization that meets outstanding quality controls systems. The system must be capable of meeting customer requirements, not that those requirements are met. **FALSE**

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

Problem 5.

Version #1

A manufacturing process is characterized by the following values:

$C_p = 1.40$ $C_{pk} = 1.12$ Target mean = 570 Actual mean = 540

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)

1.12=1.40(1-k)

k=.20

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

.20= | 540– 570 | / ((USL – LSL) / 2)

USL – LSL=300

USL= Upper specification limit=720 LSL= Lower specification limit=420

Cp = (USL – LSL) / (6 sigma)

1.40=300 / (6 sigma) 6 sigma=214

Standard deviation=sigma= 35.71

Defects below LSL=20,000Z((540-420)/35.71)=10,000Z(3.36)=20,000 (.00039)
Defects below LSL=8

Defects above USL=20,000Z((720-540)/35.71)=20,000Z(5.04)=20,000 ($2.66x10^{-7}$)
Defects above USL=0

Version #2

A manufacturing process is characterized by the following values:

C_p = 1.40 C_{pk} = 1.12 Target mean = 470 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)

1.12=1.40(1-k)

k=.20

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

.20= | 440– 470 | / ((USL – LSL) / 2)

USL – LSL=300

USL= Upper specification limit=620 LSL= Lower specification limit=320

Cp = (USL – LSL) / (6 sigma)

1.40=300 / (6 sigma) 6 sigma=214

Standard deviation=sigma= 35.71

Defects below LSL=20,000Z((440-320)/35.71)=10,000Z(3.36)=20,000 (.00039)
Defects below LSL=8

Defects above USL=20,000Z((620-440)/35.71)=20,000Z(5.04)=20,000 ($2.66x10^{-7}$)
Defects above USL=0