

**Problem 1. (20 points)**

For each motor, the present value of the operating cost =  
Purchase Price (not considered here) + Present value of (Maintenance +Electricity –Salvage Value). There are several approaches.

**Version #1:**

Motor #1:

$$\text{Present Cost} = 4,000(P/A, 6\%, 10) + 2,000(P/A, 6\%, 10) + 3,000(P/A, 6\%, 4)(P/F, 6\%, 6) - 600(P/F, 6\%, 10)$$

$$\text{Present Cost} = 6,000(7.3601) + 3,000(3.4651)(.7050) - 600(.5584)$$

$$\text{Present Cost} = \$51,154$$

Motor #2:

$$\text{Present Cost} = 25,000(P/F, 6\%, 1) + 5,000(P/A, 6\%, 10) - 100(P/G, 6\%, 10) - 800(P/F, 6\%, 10)$$

$$\text{Present Cost} = 25,000(.9434) + 5,000(7.3601) - 100(29.6023) - 800(.5584)$$

$$\text{Present Cost} = \$56,979$$

Cheapest Motor: #1

**Version #2:**

Motor #1:

$$\text{Present Cost} = 6,000(P/A, 6\%, 10) + 2,000(P/A, 6\%, 10) + 3,000(P/A, 6\%, 4)(P/F, 6\%, 6) - 600(P/F, 6\%, 10)$$

$$\text{Present Cost} = 8,000(7.3601) + 3,000(3.4651)(.7050) - 600(.5584)$$

$$\text{Present Cost} = \$65,874$$

Motor #2:

$$\text{Present Cost} = 30,000(P/F, 6\%, 1) + 5,000(P/A, 6\%, 10) - 100(P/G, 6\%, 10) - 800(P/F, 6\%, 10)$$

$$\text{Present Cost} = 30,000(.9434) + 5,000(7.3601) - 100(29.6023) - 800(.5584)$$

$$\text{Present Cost} = \$61,696$$

Cheapest Motor: #2

The factors were obtained from the table supplied.

**Problem 2. (24 points)**

- A. The project completion time for a PERT Chart is assumed to be a normally distributed random variable. This assumption is most closely related to the concept that the individual activity times are uncorrelated random variables, and the central limit theorem applies to the sum. (b)
- B. A utility company sometimes adjusts the cost of power if a purchaser adjusts the load power factor to be less lagging (closer to unity). A plant is normally lagging because of the presence of lagging machinery, and the line is also lagging. A less lagging power factor for the plant would mean lower current for the same real power to the plant. The lower current would produce less power loss in the line, so the power company would be willing to charge a reduced rate. (b)
- C. The roof top of the Quality Function Deployment Diagram indicates primarily the tradeoffs and correlations among the engineering characteristics. The central rectangular part relates the customer desires to the engineering attributes. (c)
- D. For 9 equal annual payments of amount  $A_1$ , the first occurring immediately, at an interest rate of 8%.  
 $50,000 = A_1 + A_1 (P/A, 8\%, 8)$   
 $A_1 = 50,000 / (1 + 5.7466) = \$7,411$  (b)
- E. The citation-sequence system that ECE students are required to use when writing research papers and other engineering documents is the IEEE standard. (c)
- F. If a manufacturing process has an average defect rate of 1.4 defects per unit, then the probability that a particular unit will have greater than one defect is equal to one minus the probability that it has (zero defects plus the probability that it has one defect).

$$P(>1) = 1 - (P(0) + P(1)) = 1 - P(0) - P(1)$$

$$\text{Prob} \{ k \text{ defects} \} = (dpu)^k / k! e^{-dpu}$$

$$\text{Prob} \{ 0 \text{ defects} \} = (dpu)^0 / 0! e^{-dpu} = e^{-1.4} = 24.7\%$$

$$\text{Prob} \{ 1 \text{ defects} \} = (dpu)^1 / 1! e^{-dpu} = 1.4e^{-1.4} = 34.5\%$$

$$P(>1) = 1 - P(0) - P(1) = 1 - 2.4e^{-1.4} = 40.8\% \text{ (d)}$$

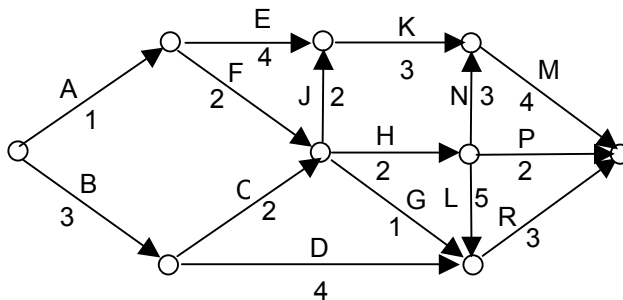
- G. A profession is characterized by a shared body of knowledge, self regulation, professional societies and peer review. The concept of a profession is independent of whether a professional is self-employed or not. (c)
- H. A manufacturing process step, involving inspection with perfect repair and 100% coverage, has a first-time yield of 75%. For a FTY of .75.  $dpu = -\ln(.75) = .2877$ . While producing 1000 good units the number of total tests that will have to be performed is equal to  $(1 + dpu)1000 = 1,288$  (b)

**Problem 3. (9 points)**

- A. Recycling is the process whereby a discarded product is returned to its basic material components. This is an expensive process. Technology changes would not normally render the materials worthless, because they normally could just be used in another product. #1
- B. Between is used when there are two persons or items; among is used when there are more than two: between the two students, among the three students. Affect is usually used as a transitive verb, meaning “to influence.” Effect is usually the one used as a noun, meaning the intent, appearance, or the accomplishment.” #2
- C. Less applies to matters of reduced degree; fewer applies to items that are countable. One would say “fewer students,” as opposed to “less students”, which is incorrect. Less is usually used to describe distances: “less than 500 kilometers” is correct. #1

**Problem 4. (13 points)**

- A. (7 points) terms of activity letters in order from start to finish. Example: AEKM, duration=12



Critical Path=longest path=B C H L R

Project Duration=length of critical path=15

- B. (6 points)

**Version #1:**

- (i) Activity K: Latest start = Project duration -length of longest backward path

Latest start for Activity K=15-7=8

Earliest start for Activity K=7

Float for Activity K=8-7=1

- (ii) Float for Activity H=0, since all activities on the critical path have a float of zero.

**Version #2:**

(i) Activity E: Latest start = Project duration -length of longest backward path

Latest start for Activity E=15-11=4

Earliest start for Activity E=1

Float for Activity E=4-1=3

(ii) Float for Activity H=0, since all activities on the critical path have a float of zero.

**Problem 5. (15 points)**

**Version #1**

- A. For the accelerated cost recovery method of depreciation, the depreciation expense charged is determined by multiplying the unadjusted basis times a percentage. The percentage is determined by law for each class of property. Salvage value and actual working life is irrelevant. It is called accelerated because more of the expense is allocated to the earlier periods, in order to lower income taxes and encourage investment. (False)
- B. A prototype, which is defined as an original model designed to be used as a basis for more refined versions, is an independent concept from that of modular, which means that the design consists of an assemblage of separate component assemblages. (False)
- C. The term biennial only means occurring every two years; the term semiannual only means occurring twice a year. Therefore regular semiannual payments occur four times more often than do regular biennial payments. (True)
- D. For the Payback Period method of project comparison, one merely determines the amount of time required to recoup the original investment, without regard for the time-value of money. One does not use the P?/F factor (False)
- E. The effective rate of interest is always greater than the nominal rate if the compounding period is less than one year, assuming a non-zero rate. (True)
- F. In group decision-making, the number of possible communication interactions is not linearly proportional to the number of group members. If the group has N members, each member can interact with N-1 others. By considering each member, there are  $N(N-1)/2$  possible interactions, with the 2 in the denominator preventing double counting. For large N, the leading term is  $N^2/2$ . (False)
- G. The general structure of all critiques (engineering, music, movie, academic/non-academic) is similar. This was discussed in detail in lecture by Ms. Bourgeois. (True)
- H. For the afternoon portion of the Fundamentals of Engineering Exam, one does not have to take a discipline-specific exam, such as in electrical or mechanical engineering, but one may select a general/other option. (False)

**Version #2**

B. See E. above.

E. See B. above.

**Problem 6. (9 points)**

Specification: target mean= $1.2 \times 10^{-4}$  henrys; LSL=  $1.0 \times 10^{-4}$  henrys; no USL;  
actual mean= $1.1 \times 10^{-4}$  henrys; standard deviation= $5.0 \times 10^{-6}$  henrys

Fraction of expected defects,  $Z((1.1-1.0)/.05)=Z(2.0)=.022750$

**Version #1**

One batch of 10,000 inductors;

Number of defective inductors =

$$.022750(10,000)=228$$

**Version #2**

One batch of 20,000 inductors;

Number of defective inductors=

$$.022750(20,000)=455$$