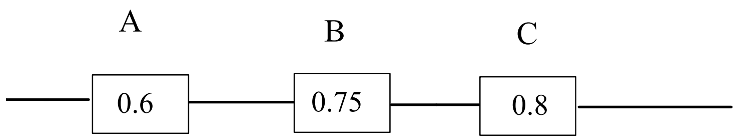
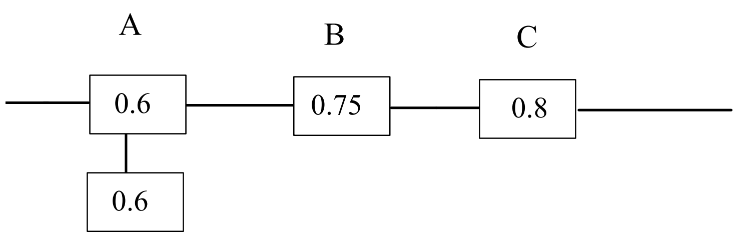
# Reliability and Redundancy

3) A welding machine has three components, A,B, & C, which must function in order for the welder to function. Reliabilities of these are .6,.75,and .8, respectively.

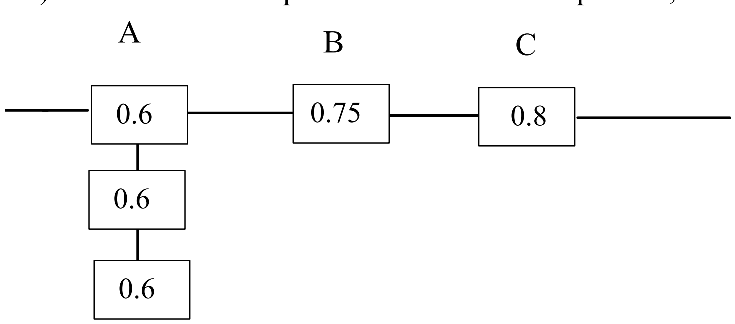



a) Calculate reliability of the system with no backups.

b) If the least reliable component, A, were backed up with an identical component, what would the new system reliability be?




c) If A were backed up with two identical components, what would the new system reliability be?




d) If the cost of a system failure is $30 K and a having a backup unit A available ( whether or not it's used) costs $3 K per production cycle, how many backups would you keep to minimize total cost?

a) Probability the welder works is the joint probability that all three parts work
0.6*0.75*0.8 = 0.36

b) With one backup part for A, in the event the original part A doesn't work, we have a spare which will work with Pwork=0.6. Thus, you add the additional reliability for the A part into the calculation:

(0.6+0.4*0.6)*0.75*0.8 = 0.504

c)With two backups for part A, this becomes a little more complex

(0.6+0.4*0.6+0.16*.6)*0.75*0.8 = 0.5616
The reliability of the 3 parts in section A can be more conveniently calculated as 1 - the probability that all three fail. If the probability of working for each is 0.6, then Pfail for each is 0.4, and the probability that all 3 fail is 0.4*0.4*0.4, or 0.064. Thus Pwork=1-Pfail=0.936
Probability the whole thing works is 0.936*0.75*0.8 = 0.5616

d) Expected cost of failure is Pfail X cost if it fails
cost of extra parts depends on how many extra you have
add these two costs together to get the total cost of items that change as we add more backups
the base cost can be ignored as it will be the same in each case

none: (1- 0.36) * $30K + 0 = $19.2K
one: (1- 0.504) * $30K + $3K = $17.88
two: (1- 0.5616)* $30K + $6K = $19.152K
One backup is the lowest total cost