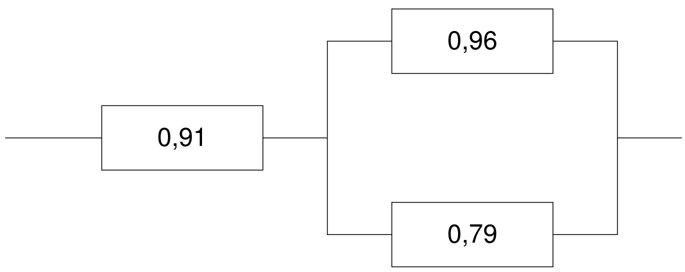
1. Consider the following scale up by a factor of l for a three stage factoring of a rearrangeable network via $N = p \times q$ as shown in slide 4-44. Suppose now we replace each edge by l edges, each $p \times p$ switch by an $lp \times lp$ switch, and each $q \times q$ switch by $lq \times lq$ switch. Show that the resulting $lN \times lN$ switch is rearrangeable. Furthermore, show that the above scale up has unneccessary crosspoints for constructing $lN \times lN$ rearrangeable network. (Hint: Consider an equivalent $lN \times lN$ Clos network.)

2. Construct a 128×8 concentrator using 8×8 crossbars and 4×1 multiplexers. The concentrator should be non-blocking in the sense that any 8 out of the 128 inputs can be connected to the 8 outputs.

3. Consider a switch with 8 STM-16 (that is 16 times STM-1 rate) ports using central memory buffering. Only the payload of the SDH frames are stored and retrieved from the buffer.
   (a) What is the required memory bandwidth?
   (b) If 166 MHz SDRAM modules are used, what is the width of the memory bus? If each module is 64-bit wide, how many modules are required in parallel?
   (c) If 32-bit wide 333 MHz dual data-rate (DDR) (that is at each clock cycle two words can be read, so the data rate is 666 MHz) SRAM devices are used, what is the width of memory bus and how many devices are required in parallel.
   (d) Compare the scalability of SDRAM and DDR-SRAM solutions if the capacity for SDRAM module is 256 MB and DDR-SRAM device 1 Mbit.

4. What is the reliability of the system below? What is the optimal place to add a spare module (reliability = 0.95) and what is the new reliability that is achieved?



5. Consider a system with two redundant units in parallel. Both the active and standby units are energised. For both units the failure rate is $\lambda = 1/100$ days and the repair rate is $\mu = 1/6$ hours. If the active unit fails, the standby unit takes its tasks and the failed unit undergoes repairs. Make a Markov model for the system, form the equilibrium equations (as functions of λ and μ) and solve the state probabilities for each of the states. Note that if the both units have failed they are repaired consecutively.