Problem #1- Design a magnitude comparator for two integers in the range [0,3] using only AND and XOR gates. The output has three values: greater, equal, and smaller. Begin from the high level description, use Boolean algebra for minimization (and not K-maps or the Tabular method), and then show the gate network. Show all the intermediate steps. You may assume that the inputs are available in their complement forms as well.

Problem #2- For the following expression, using K-maps, find its minimal sum of products and product of sums. Are they unique? Show all the intermediate steps including all prime and essential (if any) implicates and implicands.

\[ E(w,x,y,z)=\Sigma(0,4,5,9,11,14,15), \quad dc(w,x,y,z)=\Sigma m(2,8) \]

Problem #3- Using a PLA or PAL, implement a system that converts from BCD to Excess-3. Discuss the differences in using this PLA versus designing a gate network for this particular function, in terms of propagation delay, network size, etc.

Problem #4- Based on the repeated application of Shannon's decomposition, show a tree of multiplexers implementing an eight-input odd-parity checker.