- 1. Consider the recursive construction of an $N \times N$ rearrangeably non-blocking Clos network using only $p \times p$ crossbars only.
 - (a) Show that the number of crosspoints n_{cp} is given by

$$n_{cp} = Np \left(2\log_p N - 1 \right)$$

as a function N and p. Hint: you should first find out how many rounds of factorisation is required to deconstruct an $N \times N$ Clos network and then apply the recursive construction.

- (b) For large N, show that p = 3 minimises the crosspoint count.
- 2. Compute the crosspoint complexity, logical depth (the number of logical gates in a path), and fan-out (the number of logical gates driven by the input or by any gate in the network) for the following networks.
 - (a) The full $N \times N$ crosspoint switch.
 - (b) The three stage rearrangeable Clos network constructed using $\sqrt{N} \times \sqrt{N}$ switches.
 - (c) The Benes network.
- 3. A 2×2 crossbar has 4 crosspoints. How many crosspoint settings (valid and invalid) there are? Use the results of Ex-1 b) and c) to determine how many legimate point-to-point and multicast connection patterns there are. Give the crossbar setup for connection patterns as logical truth tables ('0' crosspoint open, '1' crosspoint connected).
- 4. Show that the Bayan, baseline, and omega networks (slide L5-(46?)) have the self-routing property.
- 5. For the 8×8 Benes network, use the looping algorithm to find the paths for the following permutation:

input 1 23 4 56 78 output 76 53 8 4 21