

**Mestrado em Computação (IC/UFF) – Arquiteturas Paralelas II**  
**Bacharel em Ciência da Computação (DCC/UFF) – Tópicos em Arq. de Computadores II**  
**Lista de Exercícios – Prof. Vinod Rebello**

**1. Architectural Models**

- (a) Describe the architectural and operational characteristics of SIMD and MIMD computers.
- (b) Distinguish between *multiprocessors* and *multicomputers*.
- (c) Explain the differences among UMA, NUMA, COMA, CC-NUMA and NORMA computers.

**2. SIMD and Scalability**

- (a) \*In SIMD machines, instructions are broadcast from a central control unit to the individual processing elements (PEs). Given  $n$  PEs in  $k$  dimensions, how does the system performance scale with  $n$  and  $k$ ?

**3. Networks**

- (a) Interconnection networks may be characterised by a number of “active” and passive design features, describe them.
- (b) Which static and dynamic networks could be employed to connect processors for the *parallel prefix sum* problem (na pagina 16 do tópico 2)? Which is best and why? If the sequence of numbers is large, is the answer still the same?

**4. Permutations**

- (a) The routing function  $R_i(x)$  is defined as follows:

$$R_i(x) = \lfloor \frac{x}{2^i} \rfloor \times 2^i + (((x \bmod 2^i) + 2^{i-1}) \bmod 2^i) \text{ where } 1 \leq i \leq \log_2 x$$

What permutation does this represent and what is the binary representation of  $R_i(a_{n-1} \dots a_0)$ , if  $a_{n-1} \dots a_0$  is the binary representation of the parameter  $x$ .

**5. Static Networks – For a  $k$ -Cube Connected Cycles ( $k$  node CCC):**

- (a) How many rings of  $k$  nodes are there and how many nodes exist in total?
- (b) What is the *network bandwidth*, *node degree* and *network diameter* of such a network?
- (c) Which is better a 64 node CCC or a 64 node Hypercube?

**6. Dynamic Networks – Omega Networks**

- (a) How many legitimate states are there in a  $4 \times 4$  switch?
- (b) Construct a 64 input Omega network using  $4 \times 4$  switches.
- (c) How many permutations can be implemented directly in a single pass through the network without blocking?
- (d) What is the percentage of one-pass permutations compared with the total number of permutations achievable in one or more passes of the network?

**7. Performance**

- (a) \*Suppose a multiprocessor is built out of individual processors capable of sustaining 250 MFLOPS. What is the *largest fraction* of a *program’s execution time* that could be devoted to sequential operations if the parallel computer is to exceed the performance of a supercomputer capable of sustaining 1 TFLOP?