COE 308, Computer Architecture, Term 982
HW# 6

Due date: Saturday, May 15

Q.1. Suggest two advantages of MIMD multiprocessors and two advantages of SIMD multiprocessors.

Q.2. Suggest two advantages of shared memory MIMD multiprocessor systems and two advantages of message-passing MIMD multiprocessors.

Q.3. How many systems are necessary to survive any 3 systems failing in a fault tolerant system with a voter?

Q.4. Determine the minimum execution time required to add together all elements of a 33X33 element array in each of the following multiprocessor systems:

(i) An MIMD computer system with sixty-four independent processors accessing a shared memory through an interconnection network.

(ii) An SIMD computer system with 64X64 processors connected through a north-south-east-west nearest neighbor connection network. The processors only have local memory.

(iii) An SIMD computer system with 16X16 processors connected through a north-south-east-west nearest neighbor connection network. The processors only have local memory.

(iv) An SIMD computer system with sixty-four processors connected to a shared memory through an interconnection network.

Assume in all the above cases that one addition operation takes $\mathbf{t_a}$ **sec**, and that memory can be interleaved into as many modules as you want. Make and state any necessary assumptions.

Q.5. A mesh network with 4X4 processors has the connections:

$PE_i \rightarrow PE_{(i-1) \bmod 16}$ Left
$PE_i \rightarrow PE_{(i+1) \bmod 16}$ Right
$PE_i \rightarrow PE_{(i-4) \bmod 16}$ Up
$PE_i \rightarrow PE_{(i+4) \bmod 16}$ Down

Show an example of a path between two processors which are the maximum distance apart. What will be the maximum distance between any two processors if the left/right connections had wrapped round like the up/down connections.

Q.6. Suppose that a microprocessor takes 100ns to execute a task. How many processors are needed to execute the task in 20 ns assuming that only 10% of the task cannot be executed in parallel. Assume that the communication overhead is negligible. What is the

minimum time possible for executing this task assuming the use of as many processors as needed.

Q.7. Using Bernstein`s conditions, identify the statements that can be executed simultaneously in the following:

```
a = d+e
d = d * e
e = a - d
b = a * b
e = a + 1
```

Q.8. Separate the following Pascal nested loop into independent loops which can be executed on different processors simultaneously:

```
For I := 2 To 12 Do
   For J := 1 To 10 Do
        X[I] := X[I+J] * X[I];
```

Q.9. Suppose that it is required to execute the following code on a multiprocessor system with four independent processors. Separate the code into four independent segments that can be executed simultaneously on the four processors. Determine the number of interleaved memory modules necessary to avoid memory contention given that each memory module can service one processor at a time. Show how the data of array A is spread among the interleaved memory modules.

```
For (I=1; I<=4;I++){
    C[I]=0; D[I]=0;
     For (J=1;J<=4;J++){
         C[I]=C[I]+A[I,J];
          D[I]=D[I]+A[J,I];
      }
}
```

Q.10. Calculate the bandwidth and the probability that an arbitrary request is accepted for the following systems. Assume that each processor makes a request to a memory module every clock cycle.

(i) 3 processors connected to 2 memory modules using a crossbar switch.

(ii) 3 processors connected to 4 memory modules using a crossbar switch.