Benha University
Faculty of Engineering (at Shoubra)
Electrical Engineering Department
M.Sc. (Computer Systems Engineering**)**

Final Exam
Subject: Distributed and Parallel Systems - CES 601
Date: Tue 06/06/2017
Duration: 3 hours

Attempt the following questions.

№ of Questions: 5 in 1 page(s)
Total Mark: 60

Question 1: **(12** marks**)**

a) Enumerate the limitations of *implicit parallelism*. (04 marks)

b) What is *Strided Memory Access* ?
Show with example its impact on the performance of cache memory? (04 marks)

c) Compare *Crossbar Network* to *Completely Connected Network*. (04 marks)

Question 2: **(12** marks**)**

a) Define *mapping expansion* and *mapping dilation*. (03 marks)

b) Why is it difficult to construct a true shared-memory computer?
What is the minimum number of switches for connecting *p* processors to a *b* words memory? (03 marks)

c) Show how to embed a *p*-node three-dimensional mesh into a *p*-node hypercube.
What are the allowable values of p for your embedding? (06 marks)

Question 3: **(12** marks**)**

a) What is the distinction between *task-dependency graph* and *task-interaction graph*? (04 marks)

b) Let *d* be the maximum degree of concurrency in a task-dependency graph with *t* tasks and a critical-path length *l*. Prove that $\lceil t/l \rceil \leqslant d \leqslant t-l+1$. (04 marks)

c) In the algorithm shown below, assume a decomposition such that each execution of Line 7 is a task. Draw a *task-dependency graph* and a *task-interaction graph*. (04 marks)

```
1.   procedure FFT_like_pattern(A, n)
2.   begin
3.      m := log₂ n;
4.      for j := 0 to m - 1 do
5.          k := 2ʲ;
6.          for i := 0 to n - 1 do
7.              A[i] := A[i] + A[i XOR k];
8.      endfor
9.   end FFT_like_pattern
```

Question 4: **(12** marks**)**

a) Demonstrate the distinction between *All-to-All Reduction*, *All-Reduce* , and *Gather* operations? (04 marks)

b) Give a detailed description of an algorithm for performing *one-to-all broadcast* on a *p*-node hypercube in time $2(t_s \log p + t_w(p-1)m/p)$. (04 marks)

c) Show that if the message startup time t_s is zero, then the expression $t_w m p(\sqrt{p}-1)$ for the time taken by all-to-all personalized communication on a $\sqrt{p} \times \sqrt{p}$ mesh is optimal within a small $(\leqslant 4)$ constant factor. (04 marks)

Question 5: **(12** marks**)**

a) Consider the problem of computing the prefix sums of *n* numbers on *n* processing elements. What is the parallel runtime, speedup, and efficiency of this algorithm?
Assuming that adding two numbers takes one unit of time and that communicating one number between two processing elements takes 10 units of time, show whether the algorithm cost-optimal or not? **(**06 marks**)**

b) Dijkstra's single-source shortest paths algorithm requires non-negative edge weights. **(**06 marks**)**

i. Show how Dijkstra's algorithm can be modified to work on graphs with negative weights but no negative cycles in time Q(|E||V|).

ii. Analyze the performance of the parallel formulation of the modified algorithm on a *p*-process message-passing architecture.

Good Luck
Dr. Islam ElShaarawy