TAIBAH UNIVERSITY

Midterm II Exam

Academic Session 2018/2019
Semester II

CS424 – Introduction to Parallel Computing

Duration: 1 hour (8.00am-9.00am)
21st March 2019 (Thursday)

INSTRUCTIONS TO CANDIDATE:
- This examination paper contains **three** parts:
  - o **PART A** contains **10 MCQ** questions and
  - o **PART B** contains **5 Non-MCQ** questions
  - o **PART C** contains **2 Non-MCQ** questions (for those who took Midterm I on 28th Feb)
- There are **6 printed pages**.
- Calculator is allowed.

NAME: _____ **ID:** _____ **SECTION:** ___

Question	A	B	C	D
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
TOTAL				

Choose the BEST answer (10 marks).

1. Assume we have three elements, where `a1` is the first element. Which of the following is the correct function call to create the struct? [CLO1.1- CH3-DerivedType] MK
   A. `MPI_Type_create_struct(3);`
   B. `MPI_Type_create_struct(3, &newType);`
   C. `MPI_Type_create_struct(3, types, &newType);`
   D. `MPI_Type_create_struct(3, lengths, displacements, types, &newType);`

2. Suppose there are 3 variables stored in the memory; **x**, **y** and **z**. Determine the starting address of **y** and **z**, if the values of the displacement are:
   `array_of_displacement[] = {0, 50, 130}`
   [CLO1.1- CH3-DerivedType] MAS

Variable	Type	Starting Address
x	Integer	100
y	Integer	?
z	double	?

   A. 0, 0
   B. 50, 130
   C. 150, 230
   D. 150, 280

3. Which of the following statement is (are) true? [CLO1.1- CH5] FH
   ```
   const int thread_count = 3, n = 10;
   float val=0.0, x[n];
   #   pragma omp parallel for num_thread (thread_count)
       for (int i=0; i <n; i++) {
             val += x[i];
         }
   ```
   A. Total threads created is `n`
   B. Index `i` is private for each thread
   C. Each thread gets roughly `n/thread_count` iterations
   D. (B) & (C)

4. Which of the following statements is **not** true regarding OpenMP? [CLO1.1- CH5] MK
   A. It is an API for shared-memory parallel programming
   B. In OpenMP each thread has access to all shared variables.
   C. OpenMP does not guarantee to start all required threads.
   D. Pragmas in OpenMP allow behaviors that are originally in C specification.

5. Within OpenMP, in the _____ schedule, the iterations are assigned to the threads while the loop is executing. [CLO1.1- CH5] MAS
   A. default
   B. dynamic
   C. static with chunk size 1
   D. static with chunk size; data_size / total_num_threads

6. Data parallelism can be achieved on parallel computers that are based on ___ architecture.
   [CLO1.2- CH2] FH

A. MIMD only	B. SIMD & MIMD
C. SIMD only	D. SIMD, MISD & MIMD

7. Which of the following is **correct** regarding the main approaches to Instruction Level Parallelism? [CLO1.2- CH2] MK
   A. Pipelining arranges the functional units in stages.
   B. Multiple issue processors arranges the functional units in stages.
   C. Pipelining replicates functional units and simultaneously execute different instructions in a program.
   D. Both pipelining and multiple issue processors arrange the functional units in stages.

8. Which of the following is an example of indirect network?
   [CLO1.2- CH2] MAS

A. Omega network	B. Toroidal Mesh
C. Hypercube	D. Bus

9. The diagram on the right is a ___. [CLO1.2- CH2] FH

   A. distributed-memory UMA system
   B. distributed-memory NUMA system
   C. shared-memory UMA multicore system
   D. shared-memory NUMA multicore system

Chip 1			Chip 2	
Core 1	Core 2	↔	Core 1	Core 2
Interconnect			Interconnect	
Memory			Memory	
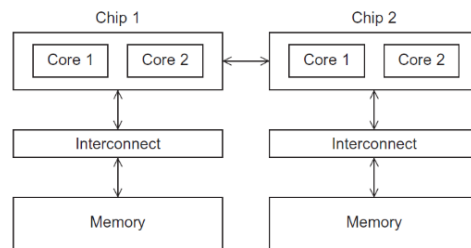
10. Which of the following is used to check whether OPENMP is defined or not? [CLO2.1- CH5] MK

A. #ifdef _OPENMP	B. #if
// OPENMP statements	// OPENMP statements
#endif	#endif
C. #ifOPENMP	D. #ifOPENMP_ def
// OPENMP statements	// OPENMP statements
#endif	#endif

PART B (5 marks)
Answer on the question paper.

11. Give two hardware examples usage of SIMD computing! [CLO1.2- CH2] MAS

Answer:
I. Vector processors
II. Graphics processing units

12. Given the following code:
   (a) Will function `Calc()` be executed in parallel?
   (b) If not, rewrite the code. [CLO2.1- CH5]

```
      result = 0.0;
#    pragma omp parallel num_threads (thread_count)
     {
#        pragma omp critical
         result += Calc (double a, double b, int n);
      }
```

Answer:
   (a) _____

   (b)

(a) The execution of function Calc() will be sequentialised.
(b) Here is one of the solutions - using critical, you can find the solution using reduction in slide.

```
      result = 0.0;
#    pragma omp parallel num_threads (thread_count)
     {
         double Local_result = 0.0;
         Local_result = Calc (double a, double b, int n);
#        pragma omp critical
         result += Local_result;
     }
```

13. Complete the following pragma with the **best** directive to avoid the race condition problem when parallelizing the following code? [CLO2.1- CH5] MK

```
# pragma omp _____
balance  =  balance + amount;
```

Answer:
```
# pragma omp atomic
balance  =  balance + amount;
```

14. Given the efficiencies of a parallel program (as illustrated in the table below).
    (a) Determine whether the program is scalable or not?
    (b) What is your justification? [CLO2.2- CH3-Performance] MAS

Number of proccesses	Number of data (problem size)				
	1024	**2048**	**4096**	**8192**	**16384**
1	1.00	1.00	1.00	1.00	1.00
2	0.98	0.92	0.93	0.94	0.94
4	0.81	0.85	0.88	0.89	0.89
6	0.71	0.73	0.75	0.78	0.79

(a) _____

(b) _____

Answer:
a) It is **NOT** scalable
b) because as the problem size increases the efficiency decreases as the number of processes increase

15. Given the run-time of a matrix vector multiplication on varying number of processes and matrix sizes (as in the figure).   [CLO2.2- CH3-Performance]

Comm_sz	Order of Matrix			
	1024	**2048**	**4096**	**8192**
1	4.1	16.0	64.0	270
2	2.3	8.5	33.0	140
4	2.0	5.1	18.0	90

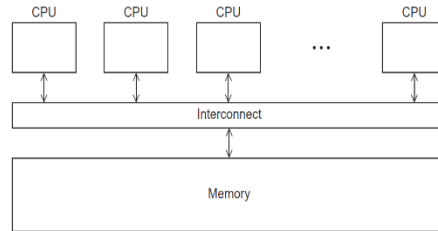Calculate the speed-up, S, for 4 processors with matrix size 8192.

Answer:
$S = T_{seq}/T_{par} = 270/90 = 3.0$

PART C (2 marks)
Answer on the question paper.

16. The diagram below is a _____ system. [CLO1.1 & CLO1.2]

Answer:
Shared-memory

17. Identify the best directive and chunk size in the following OpenMP code which will produce iterations-to-thread assignment as depicted in the table below.   [CLO2.2] or [CLO2.1 & 2.2]

Based in the following iteration schedule table, Complete the following pragma with the best directive and the best schedule for parallelizing the following code?

Thread#	Iteration				
Th$_0$	0	2	4	6	8
Th$_1$	1	3	5	7	9

```
#pragma omp ................. num_threads(2) schedule(static, ......)
for(int i = 0; i < 100; i++){
      printf("%d ", i);
}
```

Answer:
```
#   pragma omp parallel for num_threads (2) schedule(static,1)
for(int i = 0; i< 100; i++){
      printf(i);
}
```

Question	CLO	Chapter	MCQ	non-MCQ
1	1.1	CH3-DerivedType	☑	
2	1.1	CH3-DerivedType	☑	
3	1.1	CH5	☑	
4	1.1	CH5	☑	
5	1.1	CH5	☑	
6	1.2	CH2	☑	
7	1.2	CH2	☑	
8	1.2	CH2	☑	
9	1.2	CH2	☑	
10	2.1	CH5	☑	
11	1.2	CH2		☑
12	2.1	CH5		☑
13	2.1	CH5		☑
14	2.2	CH3-Performance		☑
15	2.2	CH3-Performance		☑

1.1 [5%] Describe parallel programming models and the principles of parallel algorithm design

1.2 [5%] Recognise the different parallel architectures

2.1 [3%] Develop parallel programs on shared and distributed-memory systems using task- or (and) data-decomposition

2.2 [2%] Analyse the performance of parallel programs.

A) 1,4,7,10,13   MK
B) 2,5,8, 11, 14   MAS
C) 3,6,9, 12, 15   FH