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Department of Engineering Sciences
IKC-MH.57
Introduction to High Performance and Parallel Computing
Take-home Midterm Examination
April 07, 2023 16:00 – May 01, 2023 23:59
Good Luck!

NAME-SURNAME:

SIGNATURE:

ID:

DEPARTMENT:

DURATION: Due to May 01, 2023

◇ **Answer all the questions**
◇ **Prepare your report/code(s).**
◇ **Copy your files into a directory named as your ID.**
◇ **Upload a single file by compressing this directory to UBYS.**

Question	Grade	Out of
1		30
2.1		10
2.2		10
2.3		10
3		40
TOTAL		

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1. **(30 Pts)** Summation of numbers is performed both in serial and parallel ways. For parallel computation, the environment is the networked workstations and the sequential computation is also done in the same cluster. The following table is obtained;

TIME	$nproc = 1$	$nproc = 2$	$nproc = 3$	$nproc = 4$	$nproc = 5$	$nproc = 6$
100	0.013541	0.015713	0.015420	0.017393	0.018216	0.025741
200	0.018175	0.018387	0.019951	0.022900	0.026010	0.030067
500	0.036738	0.027887	0.032696	0.041647	0.433383	0.049059
1000	0.072881	0.047775	0.060789	0.093839	0.097799	0.113722
2000	0.145120	0.078808	0.111233	0.188817	0.143317	0.211288
5000	0.365731	0.197714	0.269206	0.313151	0.371891	0.347993
10000	0.749948	0.390106	0.507074	0.636745	0.665334	0.705855
20000	1.571937	0.865633	1.086707	1.225067	1.273847	1.338983

i Complete the following tables.

Speed-Up	$nproc = 2$	$nproc = 3$	$nproc = 4$	$nproc = 5$	$nproc = 6$
100	0.86	0.88			
200	0.99	0.91			
500	1.32	1.12			
1000	1.53	1.2			
2000	1.84	1.3			
5000	1.85	1.36			
10000	1.92	1.48			
20000	1.82	1.45			

Efficiency	$nproc = 2$	$nproc = 3$	$nproc = 4$	$nproc = 5$	$nproc = 6$
100	0.43	0.29			
200	0.49	0.3			
500	0.66	0.37			
1000	0.76	0.4			
2000	0.92	0.43			
5000	0.92	0.45			
10000	0.96	0.49			
20000	0.91	0.48			

ii Analyze the tables in detail.

iii How many processor should be used for a specific value of N? Why?

2. (30 Pts) Answer the following questions. **Choose only 3 of them.**

   i Describe the Flynn's classification for computers. Which type of the computer we have made use of?

   ii Is it possible to have a system efficiency (E) of greater than %100? Discuss.

   iii Describe Blocking and Nonblocking Message-Passing.

   iv Compare briefly the point-to-point and collective communications.

   v What could be your criteria to choose a shared- or distributed-memory programming technique.

   vi Discuss the concept of communication overhead.

3. (40 Pts) The following program calculates the sum of the elements of an array as sequentially.

```
#include <stdio.h>
#include <stdlib.h>
#define max_rows 10000000
int array[max_rows];
int main(int argc, char **argv)
{
    int i, num_rows;
    long int sum;
    printf("please enter the number of numbers to sum: ");
    scanf("%i", &num_rows);
    if(num_rows > max_rows) {
        printf("Too many numbers.\n");
        exit(1);
    }
    /* initialize an array */
    for(i = 0; i < num_rows; i++) {
        array[i] = i;}
    /* compute sum */
    sum = 0;
    for(i = 0; i < num_rows; i++) {
        sum += array[i];}
    printf("The grand total is: %i\n", sum);
}
```

   Design a parallel version of the same program using MPI calls.