THE COPPERBELT UNIVERSITY

SCHOOL OF INFORMATION AND COMMUNICATION TECHNOLOGY

SEPTEMBER, 2022 – SESSIONAL EXAMINATIONS

CS421 – HIGH PERFPRMANCE COMPUTING

TIME ALLOWED: THREE HOURS

INSTRUCTIONS :

- ➢ **Maximum Marks Available – 100**
- ➢ **This paper has SIX(6) Questions**
- ➢ **Answer Any FIVE(5) Questions**
- ➢ **All Questions Carry Equal Marks (20 marks)**

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QUESTION ONE

 a) State the six main types of shuffle exchange networks as presented in class. [**6 marks**]

 b) Given a shuffle exchange network with $N = 2^3$, Derive a perfect shuffle and its inverse.

  [**6 marks**]

 c) State, describe and assess the Shuffle exchange interconnection network using four network Metrics as discussed in class. [**8 marsk**]

QUESTION TWO

 a) Given a 4 dimensional Hypercube interconnection network, Find the total number of nodes in this network and hence or otherwise determine the nodes connected to the following nodes. [**8 marks**]

  i) 12   ii) 9   iii) 15   iv) 10

 b) Briefly discuss the simple Superscalar pipeline as a type of parallelism. [**6 marks**]

 c) Give three (3) advantages and three (3) disadvantages of Hypercube Interconnection Networks as discussed in class. [**6 marks**]

QUESTION THREE

 a) State and discuss the four network metrics as they relate to a Cube Connected Cycle (CCC) Interconnection network as discussed in class. [**8 marks**]

 b) Discuss in detail how the Crossbar Interconnection network works as discussed in class. [**8 marks**].

 c) Give four (4) drawbacks of a crossbar Interconnection network. [**4 marks**]

QUESTION FOUR

 a) Assuming we want to calculate $Fi = Cos\left(sine^{sqr(xi)}\right)$ for $x_1, x_2, x_3 \dots \dots x_8$, using 6 processors. And assuming the time for each step is two milliseconds. [**8 marks**]

  i)   Find Speedup and Efficiency for the pipeline version

  ii)   Find Speedup and Efficiency for the partitioned version

 b) Briefly discuss the Implementation of shared memory without threads parallel programming model. [**6 marks**]

 c) State six (6) characteristics that the data parallel programming model demonstrates. [**6 marks**]

QUESTION FIVE

a) Given a butterfly network with K =3, Find the total number of nodes and number of Ranks in this network and hence or otherwise find the nodes connected to the following nodes. **[8 marks]**

   i) (3,3) ii) (1,6) iii) (2,0) and iv) (1,0)

b) When designing a parallel program, the factors listed below need to be considered. Briefly discuss these factors. **[6 marks]**

   i) Load balancing ii) Granularity iii) Synchronization

c) One of the reasons for using parallel processing is due to certain limits associated with serial computing. Briefly discuss these limits [**6 marks**].

QUESTION SIX

a) Define a Many Instructions Many Data (MIMD) machine and hence or otherwise use an appropriate example other than the one used in class to illustrate your definition. **[6 marks].**

b) Briefly describe an X-Tree interconnection network and hence or otherwise state 3 advantages of this network. **[6 marks]**

c) Define speedup according to Amdahl's law and hence or otherwise calculate speedup given the following information and comment on the limits to the scalability of parallelism. **[8 marks]**

Number of Processors	Serial fraction		
	0.05	0.25	0.75
50			
70			
90			
110			

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