

# CS5225 Parallel and Concurrent Programming

## Homework 2

**Due – August 2 before 11:55 PM**

Answers can be submitted to LMS as a pdf or can hand them over during the class before the deadline.

1. Suppose you want to parallelize the multiplication of an  $m \times n$  matrix and an  $n \times 1$  vector.
  - a. Among the 6 Solution Patterns for Parallelism discussed in the class, which one would you recommend to solve this problem? Briefly explain your reasoning. [2 marks]
  - b. Write a pseudo code to perform the multiplication parallelly. [10 marks]
  - c. How much work to be performed? [2 marks]
  - d. What is the span of the algorithm? [2 marks]
  - e. How much parallelism is available in the program? [2 marks]
  - f. Will your algorithm be still useful if  $m$  is small and  $n$  is large? [2 marks]
2. The harmonic mean is one of the several kinds of averages. It is appropriate for situations when the average of rates is desired. Harmonic mean  $H$  of  $n$  positive real numbers  $x_1, x_2, x_3, \dots, x_n > 0$  can be calculated as follows:

$$H = \frac{n}{\frac{1}{x_1} + \frac{1}{x_2} + \dots + \frac{1}{x_n}} = \frac{n}{\sum_{i=1}^n \frac{1}{x_i}}$$

Outline an MPI program (using pseudo code) that can be used to calculate the Harmonic mean  $H$  of one million positive real numbers. Once the calculation is complete, all process involved in the computation need to know the value. Use relevant MPI functions. Note that it is impractical to create one million concurrent processes/threads. [10 marks]