

**Homework Assignment #2**  
**Due: October 6, 2016 at 1:00 p.m.**

1. Consider an asynchronous, failure-free distributed system. The  $n$  processes communicate by sending messages across bidirectional channels. The graph of channels between processes forms a connected graph with  $m$  edges. The processes each have a distinct id from the range  $\{1, 2, \dots, n\}$ . Initially, agents know nothing about the network graph (not even the ids of adjacent processes).

At the beginning of an execution, process number  $i$  will receive a  $k$ -bit natural number  $v_i$  as its input (for all  $i$ ). The goal is to compute the arithmetic mean of  $v_1, \dots, v_n$ : at the end of the execution, every process should know the mean value. (Note that the mean may not be a natural number itself.)

The bit complexity of an algorithm is the maximum (over all possible executions) of the total number of bits in all messages in that execution.

Describe an algorithm that uses  $O(m)$  messages to solve the problem. Try to make the bit complexity as low as possible. State what the worst-case bit complexity of your algorithm is (using  $\Theta$  notation in terms of  $n$  and  $m$ ).