E517 – Introduction to High Performance Computing
Assignment 1

1. In one sentence per bullet, define or expand each of the following terms or acronyms:

- Supercomputer
- High Performance Computing (HPC)
- metric
- flops, gigaflops, teraflops, petaflops, exaflops
- benchmark
- Linpack, HPL
- Top 500 list
- Parallel processing
- MPI
- Sustained performance
- OpenMP
- Moore's Law
- Wall clock time, time to solution
- Scaling, scalability
- Weak scaling
- Strong scaling
- Performance degradation
- Von Neumann architecture
- Shared memory
- Distributed memory
- Non-uniform memory access cache coherent model
- Commodity cluster
- GPU
- Multicore socket
- Many-core

2. What is the primary requirement that differentiates HPC from other computers? What other requirements are also important?

3. Describe the computer recognized as the first true supercomputer?

4. Suppose you have a computer that has a 5-stage pipeline and you have a workload that has an input set of operand values of size 200. Assuming that each stage takes one unit of time and that passing results from one stage to the next is instantaneous, what is the average speedup in your computer for this workload as compared to a computer with 1-stage pipeline?

5. What was the fastest computer the year that you were born?

6. Write a matrix-vector multiply code in C. Provide a Makefile in order to compile your code on BigRed 2. The code has to compile upon invocation of the 'make' command on BigRed 2. Use dynamic memory allocation (malloc) for both the matrix and vector. Download the following matrix (size 443 x 443): https://sparse.tamu.edu/HB/bcspwr05 and compute the matrix-vector product of this matrix with the vector with elements defined by

$$v_i = \sin\left(\frac{(2\pi i)}{442}\right)$$

where i ∈ [0,442] is the vector element index.

Report the l_1 norm of the resulting matrix-vector product. Compute the number of floating point operations per second achieved in the matrix-vector computation.