1 Hands-on; Shared Memory III; MPI with Pthread, OpenMP

1. **Computes the dot product of two vectors**;

    - Serial - Serial program.
    - Pthreads only - A shared memory programming model using Pthreads.
    - MPI only - A distributed memory programming model with MPI.
    - MPI with pthreads - A hybrid model that utilizes both MPI and Pthreads to execute on systems that are comprised of clusters of SMP's.
    - Makefile - Use as

      ```
      make -f makecode5154
      ```

    In general, there may be problems if multiple threads make MPI calls. The program may fail or behave unexpectedly. If MPI calls must be made from within a thread, they should be made only by one thread.

2. **Another example (program)** for MPI with Pthread.

3. **OpenMP**. Two example programs are given; hello, workshare. Follow the steps below before executing OpenMP codes;

    ```
    export PGI=/usr/local/pgi
    export PATH=$PGI/linux86/6.2/bin:$PATH
    export MANPATH=$MANPATH:$PGI/linux86/6.2/man
    export LD_LIBRARY_PATH=/usr/local/pgi/linux86/6.2/liblf:
    /usr/local/pgi/linux86/6.2/lib:$LD_LIBRARY_PATH
    ```

4. **Hello world**

    - In this simple example, the master thread forks a parallel region.
    - All threads in the team obtain their unique thread number and print it.
    - The master thread only prints the total number of threads. Two OpenMP library routines are used to obtain the number of threads and each thread's number.

      ```
      export OMP_NUM_THREADS=4
      pgcc -o omp_hello code25.c -mp
      ```

5. **Loop work-sharing**

- The iterations of a loop are scheduled dynamically across the team of threads.

- A thread will perform CHUNK iterations at a time before being scheduled for the next CHUNK of work.

```
pgcc -o omp_workshare code26.c -mp
```