Name: ____________________

Directions: **Work only on this sheet** (on both sides, if needed); do not turn in any supplementary sheets of paper. There is actually plenty of room for your answers, as long as you organize yourself BEFORE starting writing.

Answers to fill-ins must be result in one (not more) grammatically correct sentence.

1. (15) Consider a network for communication among PEs in the form of a ring. PE0 is connected to PE1, PE1 to PE2, and so on, and finally PE(n-1) is connected to PE0. At every clock cycle, PEi sends a packet to PE[(i+1) mod n], i = 0,1,...,n-1. Give the entries for the table on p.21 for this new network.

2. (15) Fill the blank: Consider a function **f()** in a threaded program. If it does not access any globals, its memory accesses should not cause cache coherency problems, because each thread has ____.

3. The Intel instruction set includes MOVS ("move string"), which will copy a specified number of bytes from one location in memory to another. However, the LOCK prefix is not allowed here.

(a) (10) Show exactly where in our book this disallowance is confirmed.

(b) (15) Fill the blank: It is disallowed because allowing it would cause ____.

4. (15) Suppose you see code, written by someone else, that includes a very long **int** array **z** on a shared-memory, 64-bit machine. References to **z** are only of the form **z[128*i]**, **z[128*j]** and so on. Fill in the blanks: The likely motivation for this odd code is that the programmer is trying to avoid ____, and the size of this machine's ____ is ____.

5. This problem concerns the OpenMP example implementing the Dijkstra algorithm, pages 40ff.

(a) (20) Unlike the pseudocode on p.42, there is no **Done** array in the actual code. Suppose we were to add code to have such an array, named **done**. We could declare it between lines 17 and 18, allocate it between lines 33 and 34, and initialize its values to all 0s between lines 44 and 45. State the line number(s) at which we could change the code so to assign **done**' elements, and state the code needed for that.

(b) (10) Suppose I had forgotten to write line 77. Which of the following would then be true? (i) The program would still work correctly. (ii) The program might or might not work correctly, depending on which random numbers were generated in **init()**. (iii) The program would definitely give incorrect results. (iv) The program would trigger a seg fault. (v) None of the above.

Solutions:

1. latency $O(n)$, bandwidth $O(n)$, cost $O(n)$

2. "...each thread has its own stack"

3a. footnote 6, p.23

3b. "...would cause the bus to be locked for too long"

4. false sharing; cache blocks; 8 × 128(= 1024)

5a. Change line 102 to

```
{  notdone[mv] = 0; done[mv] = 1;  }
```

5b. (i)