1. Draw a 3-dimensional hypercube including node numbers.

```
1 --- 2 --- 3
 |    |    |
|    |    |
7 --- 6 --- 5
```

2. Embed an 8-node ring network topology into a 3x3 mesh network.

```
000 - 001 - 010 - 011 - 100 - 101 - 110 - 111
```

3. Is the following ASCII art diagramming store-&-forward or cut-through routing?

```
 3 | 3 | 3 | 3 |
 2 | 2 | 2 | 2 |
 1 | 1 | 2 | 1 |
```

4. Does the following MPI program end up in a state of deadlock or livelock?

```c
void main(int argc, char *argv[]) {
    int message, P, rank, tag=99;      MPI_Status s;
    MPI_Init(&argc, &argv);
    MPI_Comm_size(MPI_COMM_WORLD, &P); // numProcs
    MPI_Comm_rank(MPI_COMM_WORLD, &rank);
    while (1) {
        MPI_Recv(&message, 1, MPI_INT, (rank+1) % P, tag, MPI_COMM_WORLD, &s);
        MPI_Send(&message, 1, MPI_INT, (P*(rank-1)) % P, tag, MPI_COMM_WORLD);
    }
    MPI_Finalize();
}
```

5. Given the sequential execution time, $t_{seq}$, the parallel execution time, $t_{par}$, and the number of processes, $n$, what is the formula for speedup?

$$S = \frac{t_{seq}}{t_{par}}$$

6. Gustaffson devised a scaled speedup factor by changing what assumption of Amdahl's Law?

   That problem size stays fixed as processes are added.

7. What does the acronym SMD stand for in Flynn’s taxonomy of parallel hardware?

   Single Instruction stream, Multiple Data streams