1. Design a **majority-rules circuit**. This is a circuit that has three inputs and one output. The value of its output is 1 if and only if two or more of its inputs are 1; otherwise, the output is 0. Note that you need only show the truth table and the sum-of-products expression. Besides, give an application when the circuit is needed. (15%)

2. Explain what a multiplexor circuit does. Be sure to state how many input and output lines it has. (10%)

3. A typical floppy disk on a PC has the following characteristics:
   Rotation speed = 7200 rev/min
   Arm movement time = 1 msec fixed startup time + 0.1 msec for each track crossed (The 1 msec time is a constant no matter how far the arm moves.)
   Number of surfaces = 2 (a double-sided floppy disk. A single read/write arm holds both read/write heads.)
   Number of tracks per surface =100
   Number of sectors per track = 20
   Number of characters per sector = 512
   (a) How many characters can be stored on a single floppy disk? (5%)
   (b) What are the best-case, the worst-case, and the average-case (assume that on the average, the read/write head must move about 30 tracks) access times to any individual sector of this disk? (10%)

4. (a) Show how the 3 queues – running, ready, waiting – of an operating system would change when the running program A loads information from the hard disk and B then C are on the ready list in that order. (5%)
   (b) Give a concrete example of how two programs on the waiting queue might cause deadlock. (5%)

5. (a) What are SIMD and MIMD architectures? (5%)
   (b) What is pipelining? What factors will affect its performance? (5%)

6. Suppose there were two "central" processing units attached to the same memory and executing different programs. Furthermore, suppose that one of these processors needs to add one to the contents of a memory cell at roughly the same time that the other needs to subtract one from the same cell. (The net effect should be that the cell ends up with the same value with which it started.)

   (a) Describe a sequence in which these activities would result in the cell's ending up with a value one less than its starting value. (5%)

   (b) How can the problem described in part (a) be solved? (10%)

7. (a) Explain the store-and-forward packet-switching communications protocol used by most WANs. (5%)

   (b) Explain the Ethernet communications protocol used by most LANs, including how it handles a collision. (5%)

8. Describe at least three security problems about traditional (unprotected) emails. How can these security problems be solved? (15%)