

## 2001 Fall MSCS Exam

Answer two out of three.

1. In the manufacture of computer circuit boards, it is common to have a machine that automatically solders wires to various points. This machine has a spool of wire, and under computer control, moves to one spot on the circuit board and connects one end of a wire; it then moves to another spot and attaches the other end of the wire. Normally, there are thousands of wires that need to be connected, so the machine has a lot of work to do. It also has to manufacture many circuit boards, and will do one board after another.

If the machine always moves at a constant speed, is it possible to change the order that connections are made so that it takes the minimum time possible to complete the wiring of a circuit board? Either give an optimal (polynomial time) algorithm for this, or explain why one is not likely. If it is not likely, provide an algorithm that is within a constant factor of optimal.

2. A set of  $n$  independent programs must be executed by deadline  $D$ , where  $D$  is a positive integer. Two identical processors are available. The durations  $d_i$  of the execution of each program  $i$  on each of the processors is given. You need to assign the  $n$  programs to the two processors so that all the programs will be executed by the deadline  $D$ .

Describe your solution; does it solve the problem for all instances? Is the problem in  $P$ ? Is it in  $NP$ ? Is it  $NP$ -complete?

3. Your company is building an airplane, and there are several subassemblies that need to be constructed; some of them must be completed before others can begin. For example, attachment of wings takes 3 days, but that cannot begin until both the wings and the fuselage are complete. There are no cyclic dependencies; to be precise, there is never an occurrence where you need  $A$  to complete  $B$ ,  $B$  to complete  $C$ , and  $C$  to complete  $A$ . Design an algorithm to determine the earliest date that the airplane can be finished, assuming you have enough employees to work on all parts at the same time.