15-410, Spring 2022, Homework Assignment 1.
Due Tuesday, March 1, 20:59:59

Please observe the non-standard submission time, **which is not midnight**. As we intend to make solutions available on the web site promptly thereafter for exam-study purposes, please turn your solutions in on time.

Homework must be submitted in either PostScript or PDF format (not: Microsoft Word, Word Perfect, Apple Works, LaTeX, XyWrite, WordStar, etc.). Submit your answers by placing them in the appropriate hand-in directory, e.g., `/afs/cs.cmu.edu/academic/class/15410-s22-users/$USER/hw1/$USER.ps` or `/afs/cs.cmu.edu/academic/class/15410-s22-users/$USER/hw1/$USER.pdf`. A plain text file (.text or .txt) is also acceptable, though it must conform to Unix expectations, meaning lines of no more than 120 characters separated by newline characters (note that this is *not* the Windows convention or the MacOS convention). Please avoid creative filenames such as `hw1/my_15-410_homework.PdF`.

1   Tape drives (10 pts.)

Consider a system with three processes and three tape drives. In *typical* operation, each process needs just one tape drive. However, every now and then in a special circumstance each of the processes might need a second tape drive briefly. In accordance with the deadlock avoidance approach, the *maximal* needs of each process are declared below:

Resource Declarations

Process A	Process B	Process C
2 tape drives	2 tape drives	2 tape drives

1.1   3 pts

Is the following state safe? Why or why not?

Who	Max	Has	Room
A	2	1	1
B	2	2	0
C	2	0	2
System	3	0	-

1.2   3 pts

Explain why the following state is not safe.

Who	Max	Has	Room
A	2	1	1
B	2	1	1
C	2	1	1
System	3	0	-

1.3   4 pts

One day your boss says that a government business efficiency investigator instrumented this system and the system was never observed using more than two tape drives, with at least one idle at all times. The efficiency investigator suggests transferring one of the three tape drives to a different business unit, leaving two. Would this system work with only two tape drives? If so, how well would it work?

2 Transfer trouble (10 pts.)

Consider the following code for trasferring money from one bank account to another.

```
int transfer(account from, account to, int amount)
{
  int available;

  /* check */
  available = from->value;
  if (available < amount)
    return (-1);

  /* commit */
  available -= amount;
  from->value = available;
  to->value += amount;
  return (0);
}
```

In a mathematical sense, it should be ok to "transfer" money from an account to itself, e.g., `transfer(A, A, 500)`.

Using the tabular format presented in class, show how concurrent invocations of the "mathematically safe" operation `transfer(A, A, 500)` can double the amount of money in account `A`.

You may use more or fewer lines or columns than are provided in this sample table.

Execution Trace

time	Thread A	Thread B	Thread C
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			