Homework 4

Due: 2:30 PM Mar. 13, 2008

To submit your code electronically, make sure that in your `home` directory you have a `course` directory and that in that there is a `cs004` directory. You should save all your programs into `.m` files. For this assignment, you will place all your code into the directory

`/u/<login>/course/cs004/hw4`

(*Change* `<login>` *to be your login name.*) After you have your code saved in the proper directory you can run the handin script. Open a terminal, then type

```
cs004_handin hw4
```

The following commands will be useful for completing the homework. You can learn more about them by entering `help x` into the MATLAB command window, where `x` is the command.

`prod, disp, input, num2str, int2str, rand, length, polyfit`

Problem 4.1

The geometric mean GM of a set of n positive numbers $\{x_1, x_2, ..., x_n\}$ is defined by:

$$GM = (x_1 \cdot x_2 \cdot ... \cdot x_n)^{(1/n)}$$

Write a user-defined function that calculates the geometric mean of a set of numbers. For function name and arguments use `GM=Geomean(x)`, where `x` is a vector of numbers (any length), and the output argument `GM` is their geometric mean. As usual, save the function in a file called `Geomean.m`. The geometric mean is useful for calculating the average return of a stock. The following table gives the return of an IBM stock in the last ten years (a return of 16% means 1.16 etc.). Use the user-defined function `Geomean` to calculate the average return of the stock. Note that MATLAB does have a built in function `geomean` with which you can use to check your answer.

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Return	1.38	1.76	1.17	0.79	1.42	0.64	1.2	1.06	0.83	1.18

Problem 4.2

Write a function `C = RentalCost(class, period)` that calculates the cost of renting a car according to the following price schedule:

Type of car	1-6 days	7-27 days	28-60 days
Class B	\$27 per day	\$162 for 7 days, +\$25 for each additional day.	\$662 for 28 days, +\$23 for each additional day.
Class C	\$34 per day	\$204 for 7 days, +\$31 for each additional day.	\$284 for 28 days, +\$28 for each additional day.
Class D	Class D cannot be rented for less than 7 days	\$276 for 7 days, +\$43 for each additional day.	\$1,136 for 28 days, +\$38 for each additional day.

The argument `class` should be `'B'`, `'C'`, or `'D'` and `period` should be the number of days the car will be rented for. If a period longer than 60 days is given, a message "Rental is not available for more than 60 days" is displayed. If a rental period of less than 7 days is entered for Class D, a message "Class D cars cannot be rented for less than 7 days" is displayed. Run your function on input for the following test cases and include them in your handin: Class B for 3, 14, and 50 days; Class C for 20, 28, and 61 days; Class D for 6, 18, and 60 days. Save your test cases in a file called `rentaltest.m`.

Problem 4.3

Write a program that determines the change given back to a customer in a self-service checkout machine of a supermarket for purchase of up to \$10. The program generates a random number between 0.01 and 10.00 and displays the number as the amount to be paid. The program asks the user to enter his/her payment, which can be one \$1 bill, one \$5 bill, or one \$10. If

the payment is less than the amount to be paid, an error message is displayed. If the payment is sufficient, the program calculates the change and lists the bills and/or coins that make up the change, which has to be composed of the least number of bills and coins. For example, if the amount to be paid is $2.33, and a $10 bill is entered as payment, then the change is: one $5 bill, two $1 bills, two quarters, one dime, one nickle, and two cents. The output for your program might look like this:

```
You owe $4.22
Enter your payment (10, 5, or 1): 10
Your change is:
1 $5
3 $0.25
3 $0.01
```

Write one script file and two function files. The script file should be named `teller.m` and should be resposible for handling user input and calling your two user-defined MATLAB functions. One user-defined function generates a random number between 0.01 and 10.00. The other user-defined function calculates and displays the composition of the change. Remember to save each of function in its own `m` file. (Hint:Your second function should include a for loop).

Problem 4.4

The greatest common divisor (GCD) of two numbers is the largest number that divides both numbers evenly. The original algorithm that the mathematcian Euclid devised to calculate the GCD of two numbers repeatedly subtracts the smaller of the two numbers from the larger until the numbers are equal. The final value for both numbers is the GCD of the original numbers. For instance, suppose $a = 49$ and $b = 35$. Performing Euclid's algorithm by hand in MATLAB might look like this:

```
a = 49;
b = 35;

a = a - b
% a is now equal to 14
```

```
b = b - a
% b is now equal to 21

b = b - a
% b is now equal to 7

a = a - b
% a and b are now equal to 7, so the gcd of 49 and 35 is 7
```

Write a function `GCD=MyGCD(a,b)` that implements Euclid's algorithm. You can check the results of your function against the built-in MATLAB function `gcd`.

Problem 4.5

Viscosity is a property of gases and fluids that characterizes their resistance to flow. For most materials vsicosity is highly sensisitive to temperature. For gases, the variation of viscosity with temperature is frequently modeled by an equation:

$$\mu = \frac{CT^{\frac{3}{2}}}{T+S} \tag{1}$$

where μ is the viscosity, T is the absolute temperature, and C and S are empirical constants. Below is a table that gives the viscosity of air at different temperatures (data from B.R. Munson, D.F. Young, and T.H. Okiishi, "Fundamental of Fluid Mechanics," 4th Edition, John Wiley and Sons, 2002).

T (in Kelvin)	μ ($N \times \frac{s}{m^2} \times 10^{-5}$)
253	1.63
273	1.71
310	1.87
373	2.17
473	2.53
573	2.98
673	3.32
773	3.64
1273	5.04

Determine constants C and S by curve fitting the equation to the data points. Make a plot of viscosity versus temperature (in Kelvin). In the plot show the data points with markers and curve-fitted equation with a solid line.

The curve fitting can be done by rewriting the equation in the form:

$$\frac{T^{\frac{3}{2}}}{\mu} = \frac{1}{C} * T + \frac{S}{C} \tag{2}$$

and using a first order polynomial.