ICE for Week 4

Problem 1

Consider the following structure plan, where M and N represent MATLAB variables:

1. Set $M = 44$ and $N = 28$
2. While M not equal to N repeat: While $M > N$ repeat: Replace value of M by $M - N$ While $N > M$ repeat: Replace value of N by $N - M$
3. Display M
4. Stop.

(a) Work through the structure plan, sketching the contents of M and N during execution. Give the output.

(b) Repeat (a) for $M = 14$ and $N = 24$.

(c) What general arithmetic procedure does the algorithm carry out (try more values of M and N if necessary)?

Problem 2

Write a script that inputs any two numbers (which may be equal) and displays the larger one with a suitable message or, if they are equal, displays a message to that effect.

Problem 3

Write a script for the general solution to the quadratic equation $ax^2 + bx + c = 0$. Use the structure plan developed before. Your script should be able to handle all possible values of the data a, b, and c. Try it out on the following values:

(a) 1, 1, 1 (complex roots)
(b) 2, 4, 2 (equal roots of −1.0)
(c) 2, 2, −12 (roots of 2.0 and −3.0).

Problem 4

We wish to examine the motion of a damped harmonic oscillator. The small amplitude oscillation of a unit mass attached to a spring is given by the formula $y = e^{-(R/2)t} \sin(\omega_1 t)$, where $\omega_1^2 = \omega_o^2 - R^2/4$ is the square of the natural frequency of the oscillation with damping (i.e., with resistance to motion); $\omega_o^2 = k$ is the square of the natural frequency of undamped oscillation; k is the spring constant; and R is the damping coefficient. Consider $k = 1$ and vary R from 0 to 2 in increments of 0.5. Plot y versus t for t from 0 to 10 in increments of 0.1.

Hint: Develop a solution procedure by working backwards through the problem statement. Starting at the end of the problem statement, the solution procedure requires the programmer to assign the input variables

first followed by the execution of the formula for the amplitude and ending with the output in graphical form.

Problem 5

```
a = [-1 0 3];
b = [0 3 1];
~a
a & b
a | b
xor(a, b)
a > 0 & b > 0
a > 0 | b > 0
~ a > 0
a + (~ b)
a > ~ b
~ a > b
~ (a > b)
```

Problem 6

Determine the values of the following expressions yourself before checking your answers using MATLAB. You may need to consult Table 5.3:

(a) `1 & -1`
(b) `13 & ~ (-6)`
(c) `0 < -2|0`
(d) `~[1 0 2] * 3`
(e) `0 <= 0.2 <= 0.4`
(f) `5 > 4 > 3`
(g) `2 > 3 & 1`

Problem 7

Given that `a = [1 0 2]` and `b = [0 2 2]` determine the values of the following expressions. Check your answers with MATLAB:

(a) `a~= b`

(b) `a < b`

(c) `a < b < a`

(d) `a < b < b`

(e) `(a |~a)`

(f) `b & (~b)`

(g) `a(~(~b))`

(h) `a = b == a` (determine final value of a)

Problem 8

Write some MATLAB statements on the command line which use logical vectors to count how many elements of a vector x are negative, zero, or positive. Check that they work, e.g., with the vector:

```
[-4 0 5 -3 0 3 7 -1 6]
```

Problem 9

The Receiver of Revenue (Internal Revenue Service) decides to change the tax table used in Section 5.5 slightly by introducing an extra tax bracket and changing the tax-rate in the third bracket, as follows:

Taxable income	Tax payable
$10,000 or less	10% of taxable income
Between $10,000 and $20,000	$1000 + 20% of amount by which taxable income exceeds $10,000
Between $20,000 and $40,000	$3000 + 30% of amount by which taxable income exceeds $20,000
More than $40,000	$9000 + 50% of amount by which taxable income exceeds $40,000

Amend the logical vector script to handle this table, and test it on the following list of incomes (dollars): 5000, 10,000, 15,000, 22,000, 30,000, 38,000, and 50,000.

Problem 10

A certain company offers seven annual salary levels (dollars): 12,000, 15,000, 18,000, 24,000, 35,000, 50,000, and 70,000. The number of employees paid at each level are, respectively: 3000, 2500, 1500, 1000, 400, 100, and 25. Write some statements at the command line to find the following:

(a) The average salary level. Use mean. (Answer: 32,000)
(b) The number of employees above and below this average salary level. Use logical vectors to find which salary levels are above and below the average level. Multiply these logical vectors element by element with the employee vector, and `sum` the result. (Answer: 525 above, 8000 below)
(c) The *average salary earned* by an individual in the company (i.e., the total annual salary bill divided by the total number of employees). (Answer: 17,038.12).

Problem 11

Write some statements on the command line to remove the largest element(s) from a vector. Try it out on `x = [1 2 5 0 5]`. The idea is to end up with `[1 2 0]` in `x`. Use `find` and the empty vector `[ ]`.