MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Civil and Environmental Engineering

1.017 Computing and Data Analysis for Environmental Applications

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Quiz 1 (Solutions)
Thursday, October 5, 2000

Please answer Problems 1-5 and either Problem 6 or Problem 7 (maximum score = 100 points):

Problem 1 (15 points)

Suppose
```
a = [ 4   3   1]
b = [ -3  2   7]
```

Evaluate the following expressions …

```
test=a.*b>6
ftest=find(a.*b>6)
```

Problem 2 (15 points)

Write a MATLAB script which generates the sequence given by:

$N(i) = 1 \qquad i = 1,2$
$N(i) = N(i - 1) + N(i - 2) \qquad i > 2$

The first few number of this sequence are: 1, 1, 2, 3, 5, 8, 13, …

Problem 3 (15 points)

Soil saturation (S) is the fraction of a soil's pore space filled by water. Suppose that this saturation is related to the capillary pressure (P) of soil water as follows:

$S = 1$ for $P < 10$
$S = 1 + 0.01(10 - P)$ for $10 \leq P < 100$
$S = 0.1$ for $P > 100$

a) Write a MATLAB function called `sp` which takes a vector of P values and returns a vector of corresponding S values.
b) Write a MATLAB function called `plotsp` that plots an S vs P curve over the range $P = 0$ to 150. The function `plotsp` should call the function `sp` to obtain values for the plotting.

Problem 4 (15 points)

Write a MATLAB function `srand` which computes `y = sin(x)` when `x` is a vector of `n` random numbers distributed uniformly over the interval between 0 and 2π (inclusive). The function should take `n` as an argument. It should also plot a histogram of `y`. All statements in this program should use arrays.

Problem 5 (15 points)

Please identify errors in the following MATLAB program and write a revised version with these errors corrected.

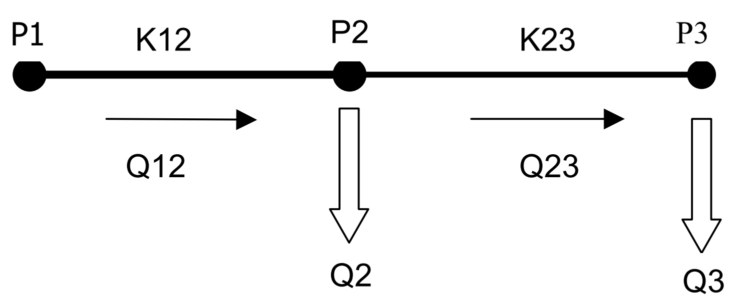
```
function main(b)
x=subfunc(a)
a=b+4;
return
function subfunc(a)
x=a.^2+1;
return
```

Problem 6 (25 points)

Write a MATLAB function called `check` that uses the internal function `load` to read in two vectors of rainfall data from two separate files (e.g. `rain1.dat` and `rain2.dat`). The two vectors can be of different lengths. If they are of different lengths, call the shorter array `short` and the longer array `long`. If the two input arrays are of the same length either could be called `short` and the other called `long`. The function `check` should define a new array called `extended` which is the same length as `long`. The first `length(short)` values in `extended` should be the same as those in `short`. The remaining should be equal to the values in the corresponding positions at the end of `long`. The function `check` should return the minimum and maximum values of `short`, `long` and `extended` (6 numbers) in an array.

Problem 7 (25 points)

The simple water distribution system shown below consists of a 2 pipes with conductivities `K12` and `K23` and 3 junctions. The pressure `P1` at junction 1 is specified (e.g. it is proportional to the constant height of water in a supply reservoir). The pressures `P2` and `P3` at junctions 2 and 3 are unknown. Water is withdrawn at a rate `Q2` at junction 2 and `Q3` at junction 3.



The pressures and flows in the system satisfy the following equations, which are derived from the conservation of mass principle and the definition of conductivity as the ratio of flow rate to pressure difference:

```
Q12 = (P1-P2)*K12
Q23 = (P2-P3)*K23
Q12-Q2-Q23=0
Q23=Q3
```

Write a MATLAB function that obtains the inputs `P1`, `K12`, `K23`, `Q1`, and `Q2` through the function argument and returns an array consisting of the values `P2`, `P3`, `Q12`, and `Q23` obtained by solving the above set of 4 equations in the 4 unknowns `P2`, `P3`, `Q12`, and `Q23`. [HINT: Rearrange the four equations so they have the standard matrix form needed to use the MATLAB equation solution operator `\`].