Remember to clearly label all plots and include any MATLAB scripts and functions with your solution. Also please remember that no late homeworks will be accepted.

1. Suppose `q=[50 40 60 80 30 90 10 5]`. What does this vector look like after each of these commands?

```
q(1:2:7)=zeros(1,4)
q(7:-2:1)=zeros(1,4)
q([3 4 8 1])=zeros(1,4)
```

2. **(a)** Use the `linspace` function to create vectors identical to the following created with colon notation:

(i) `t=5:5:30`

(ii) `x=-3:3`

(b) Use colon notation to create vectors identical to the following created with the `linspace` function:

(i) `v=linspace(-2,1,5)`

(ii) `r=linspace(6,0,7)`

3. Given that `x=0:.01:1; y=cos(x);`, write a single-line MATLAB code that returns the following.

(i) $\sum_{k=1}^{N} x_k$ (use the sum routine)

(ii) $\sum_{k=1}^{N} x_k y_k$ (do not use the sum routine)

(iii) $\sum_{k=1}^{N} x_k^2$

4. Manning's equation can be used to compute the velocity of water in a rectangular open channel:

$$U = \frac{\sqrt{S}}{n}\left(\frac{BH}{B+2H}\right)^{2/3},$$

where U = velocity (`meters/sec`), S = channel slope, n = roughness coefficient, B = width (`meters`), and H = depth (`meters`). The following data is available for five channels.

n	S	B	H
0.035	0.0001	10	2
0.020	0 0002	8	1
0.015	0.0010	20	1.5
0.030	0.0007	24	3
0.022	0.0003	15	2.5

Given the MATLAB code

```
a=[ 0.035    0.0001    10     2
    0.020    0 0002     8     1
    0.015    0.0010    20     1.5
    0.030    0.0007    24     3
    0.022    0.0003    15     2.5];
n=a(:,1); S=a(:,2); B=a(:,3); H=a(:,4);
```

Write a single-line MATLAB statement to compute a column vector containing the velocity based on the values in the parameter matrix.

5. Consider the following *finite difference quotients*

$$\text{(one-sided formula)} \; \frac{f(x+h)-f(x)}{h}, \qquad \text{(centered formula)} \; \frac{f(x+h)-f(x-h)}{2h},$$

each of which approximates the derivative $f'(x)$ of a differentiable function f.

(a) Write two MATLAB functions, with calling sequences (`fp` for f prime) `fp = onesidediff(f,x,h)` and `fp = centerdiff(f,x,h)`, which evaluate these quotients on a vector `x`, given a scalar h and a general function `f` passed using the `@` notation. Use both MATLAB functions to approximately compute the derivative of $f(x) = (1+x^2)^{-1}$ on $[-1,1]$ using `x = linspace(-1,1,100)` and `h = 1e-4`. Prepare the following plot with two subplots, using the `subplot(2,1,1)` and `subplot(2,1,2)` commands. The top plot should depict the error (in absolute value) on $[-1,1]$ between the one-sided approximation and the exact derivative, while the bottom plot should depict the error (in absolute value) on $[-1,1]$ between the centered approximation and the exact derivative.

(b) For $f(x) = e^x$ and h in the range $[10^{-1}, 10^{-2}, \ldots, 10^{-9}]$, compute $f'(0)$ (the exact value is obviously $e^0 = 1$) using the MATLAB function from **(a)**. Make a table which lists h in the first column, the one-sided approximation in the second column, the error in the one-sided approximation in the third column, the centered approximation in the fourth column, and the error in the centered approximation in the fifth column. Report h in scientific notation which a minimum number of displayed digits. Report errors in absolute value using scientific notation keeping 3 digits past the decimal. Approximations should be reported in fixed-point non-scientific notation with a full field of digits (say 14 past the decimal point).

(c) Plot the errors from **(b)** versus h on the same log-log plot. Your plot should include a legend. What do you observe?