Make sure to write down your procedure clearly and answer exactly what the problem is asking for. Points will be taken off for incomplete, unintelligible, and sloppy procedures and solutions. Include comments in all MATLAB programs.

Follow the five step problem solving in engineering and science whenever required: **1)** State the problem, **2)** Describe the inputs and outputs, **3)** Develop a Hand Example, **4)** Develop a MATLAB solution, and **5)** Test the solution. Graphs are often useful ways to check your calculations.

(20 points) 3.4 Chemical reaction rates are proportional to a rate constant k that changes with temperature according to the Arrhenius equation

$$k = k_0 e^{-Q/RT}$$

For a certain reaction,

Q = 8000 cal/mol
R = 1.987 cal/mol K
K0 = 1200 min-1

Find the values of k for temperatures from 100 K to 500 K, in 50° increments. Create a table of your results.

Solution:
1. Find the value of rate constant k
2. Inputs: k0, Q, R, T
    Output: k
3. $k = 1200e^{-8000/(1.987*100)} = 3.9242e - 015$
4.

```
%% Problem 3.4 Chemical reaction rates
Q= 8000;
R=1.987;
k0=1200;
T=100:50:500;
k=k0*exp(-Q./R./T);
[T',k']
```
5. The value obtained in step 3 is similar to what we get from MATLAB which is k = 0.0000 at k = 100.0000.

(20 points) 3.11 The displacement of the oscillatory spring shown in Figure P3.11 can be described by
$$x = A cos(\omega t)$$
where
    x = displacement at time t
    A = maximum displacement
    ω = angular frequency, which depends on the spring constant and the mass attached to the spring
    t = time.

Find the displacement x for times from 0 to 10 seconds when the maximum displacement A is 4 cm, and the angular frequency is 0.6 radian/s. Present your results in a table of displacement and time values.
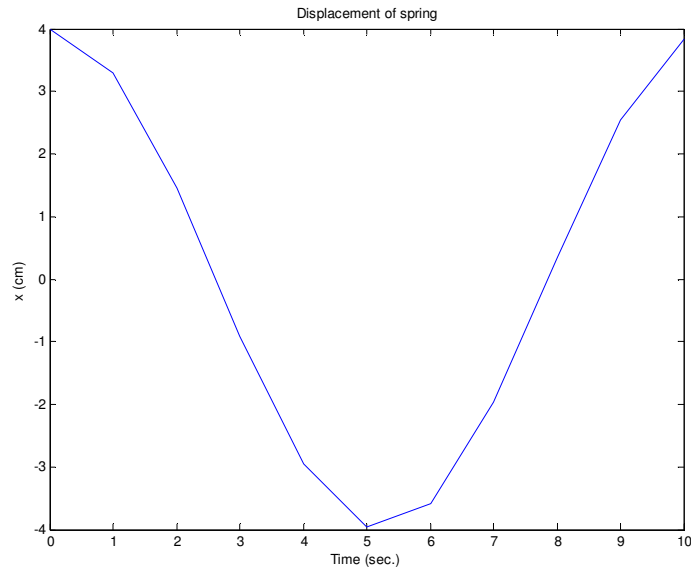
Solution:
1. Find the displacement x
2. Inputs: A, w, t
    Output: x
3. $k = 4\cos(0.6 * 0) = 4$
4.

```
%% Problem 3.11 Displacement of oscillatory spring
t=0:10;
A=4;
```

```
freq=0.6;
x=A*cos(freq.*t);
[t',x']
```

5. The value obtained in step 3 is similar to what we get from MATLAB which is x = 4.0000 at t = 0.

(20 points) 3.15 Consider the following table of data representing temperature readings in a reactor from Thermocuple1,2, and 3:

```
84.3000  90.0000  86.7000
86.4000  89.5000  87.6000
85.2000  88.6000  88.3000
87.1000  88.9000  85.3000
83.5000  88.9000  80.3000
84.8000  90.4000  82.4000
85.0000  89.3000  83.4000
85.3000  89.5000  85.4000
85.3000  88.9000  86.3000
85.2000  89.1000  85.3000
82.3000  89.5000  89.0000
84.7000  89.4000  87.3000
83.6000  89.8000  87.2000
```

Use MATLAB to find
   (a) The maximum temperature measured by each thermocouple.

Solution:
```
maximum=max(tc)
```

maximum =
   87.1000   90.4000   89.0000

(b) The minimum temperature measured by each thermocouple.

Solution:
```
minimum=min(tc)
```

minimum =
  82.3000 88.6000 80.3000

(20 points) 3.17 The vector

G = [68,83,61,70,75,82,57,5,76,85,62,71,96,78,76,68,72,75,83,93]

represents the distribution of final grades in a dynamics course. Compute the man, median, mode, and standard deviation of G. Which better represents the "most typical grade," the mean, median, or mode? Why? Use MATLAB to determine the number of grades in the array (don't just count them) and to sort them into ascending order.

Solution:
```
mean(G)
median(G)
mode(G)
std(G)
sort(G)
length(G)
```

ans =
  71.8000

ans =
  75

ans =
  68

ans =
  18.6169

ans =
  Columns 1 through 12
    5   57   61   62   68   68   70   71   72   75   75   76

  Columns 13 through 20
   76   78   82   83   83   85   93   96

ans =
  20

(20 points) 3.23 Impedance is related to the inductance, L, and the capacitance, C, by the following equations

$$Z_C = 1/j\omega C \text{ and } Z_L = j\omega L$$

For a circuit similar to the one shown in Figure P3.22 assume the following:
    C = 1μF (microfarads)
    L = 200 mH (millihenries)

R = 5 ohms
F = 15 kHz (kilohertz)
$\omega = 2\pi f$
V = 10 volts

(a) Find the impedance for the capacitor (Z_C) and the inductor (Z_L).

Solution:
1.   Find the value of impedance of the capacitor and the inductor
2.   Inputs: C, L, R, F, w, V
     Output: Z_C and Z_L
3. $Z_C = \frac{1}{j*2*\pi*15,000*0.000001} = -10.6103i$
     $Z_L = j*2*\pi*15,000*0.2 = 1.885e4i$

4.
```
%% Problem 3.23 Calculation of impedance
C=1e-6;
L=200e-3;
R=5;
f=15e3;
w=2*pi*f;
V=10;
% Impedance of capacitor ZC, and inductor ZL
ZC=1/(w*C*j)
ZL=w*L*j
% Total impedance
ZT=ZC+ZL+R
% Current
I=V/ZT
% Magnitude and angle of current
I_mag=abs(I)
ang = angle(I)

 [T',k']
```

5.
```
ZC =
     0 -10.6103i

ZL =
     0 +1.8850e+004i
```

(b) Find the total impedance

$$Z_T = Z_C + Z_L + R$$

Solution:
The only real part in the total impedance is due to R, since the capacitor and inductor impedances have 0 real part in them
$Z_T = 5 + (0-10.6103i)+(0+1.885e4i) = 5 + 1.884e4\ i$

```
ZT =
  5.0000e+000 +1.8839e+004i
```

(c) Find the current by solving Ohm's law for I.

$$V = I\, Z_T$$

Solution:
I = V/Z_T = 10/(5+1.884e4i) = 1.409e-7 - 5.308e4i

I =
 1.4088e-007 -5.3082e-004i

(d) Electrical engineers often describe complex parameters using polar coordinates, that is, the parameter has both an angle and a magnitude. (Imagine plotting a point on the complex plane, where the x-axis represents the real part of the number, and the y-axis represents the imaginary part of the number.) Use the abs function to find the magnitude of the current found in part c, and use the angle function to find the corresponding angle.

I =
 1.4088e-007 -5.3082e-004i

Solution:
$|I| = \sqrt{1.4088e - 7^2 + 5.308e - 4^2} = 5.308e - 4\ A$ (Should be a small number since the real and imaginary parts are also very small).

I_mag =
 5.3082e-004

Solution:
The current has a positive real part and a negative imaginary part, so the angle has to be negative.

ang =
 -1.5705 **(In radians !!)**