ECE 111 - Homework #1

Week #1: Matlab Introduction

Bison Academy: Homework Sets & Solutions

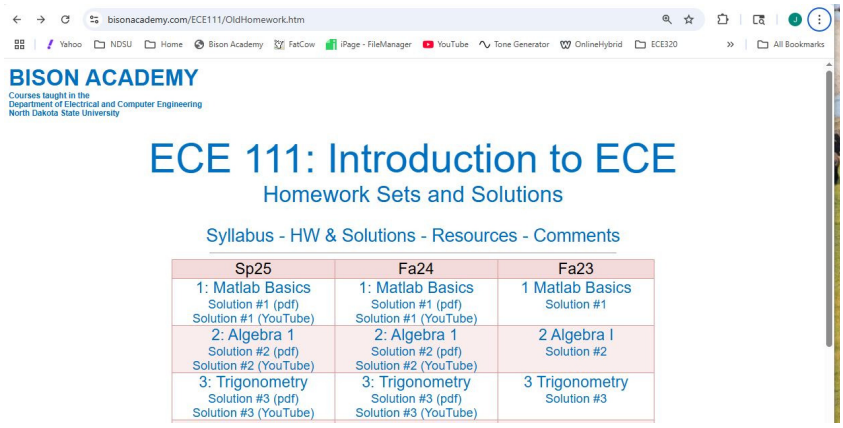
1) What are the solutions to

$$y = \cos(3x)$$

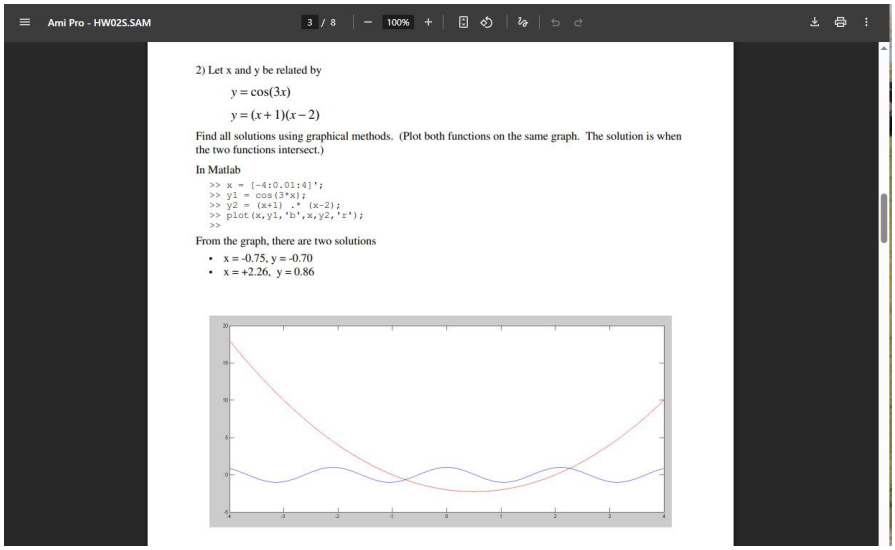
$$y = (x+1)(x-2)$$

hint: See homework #2, problem #2 solutions for Fall 2024

You can find solutions to previous homework sets on Bison Academy.



The problems and answers change each semester, but you can see how similar problems are solved and what Matlab commands can be used



Roots to a Polynomial

2) Use the *roots()* command to find the roots to

a) $y = x^3 - 5x^2 - 196x + 980$

```
>> P = [1,-5,-196,980]

P =     1    -5  -196   980

>> roots(P)


  -14.0000
   14.0000
    5.0000
```

b) $y = x^4 - 36x^3 + 469x^2 - 2610x + 5200$

```
>> P = [1, -36, 469, -2610, 5200]

P =           1         -36         469       -2610        5200

>> roots(P)

   13.0000
   10.0000
    8.0000
    5.0000
```

c) $y = x^5 - 5x^4 - 97x^3 + 641x^2 + 480x - 6300$

```
>> P = [1 -5 -97 641 480 -6300]

P =           1          -5         -97         641         480       -6300

>> roots(P)

  -10.0000
   -3.0000
    7.0000
    6.0000
    5.0000
```

Matlab as a Graphing Calculator:

Assume a thermistor (temperature sensitive resistor)and voltage divider have the following relationship:

$$R = 5000 \cdot \exp\left(\frac{4100}{T+273} - \frac{4100}{298}\right)\Omega$$

$$V = \left(\frac{R}{R+2000}\right) \cdot 5V$$

3) Determine the resistance and voltage if

T = 10 degrees C (tap water)

```
>> T = 10;
>> R = 5000 * exp(4100/(T+273) - 4100/298)

R =  1.0368e+004

>> V = R / (R + 2000) * 5

V =    4.1914
```

T = 30C (hot water)

```
>> T = 30

T =    30

>> R = 5000 * exp(4100/(T+273) - 4100/298)

R =  3.9845e+003

>> V = R / (R + 2000) * 5

V =    3.3290
```

4) Plot the resistance vs. light level for 0 <T < 50. From the graph, determine

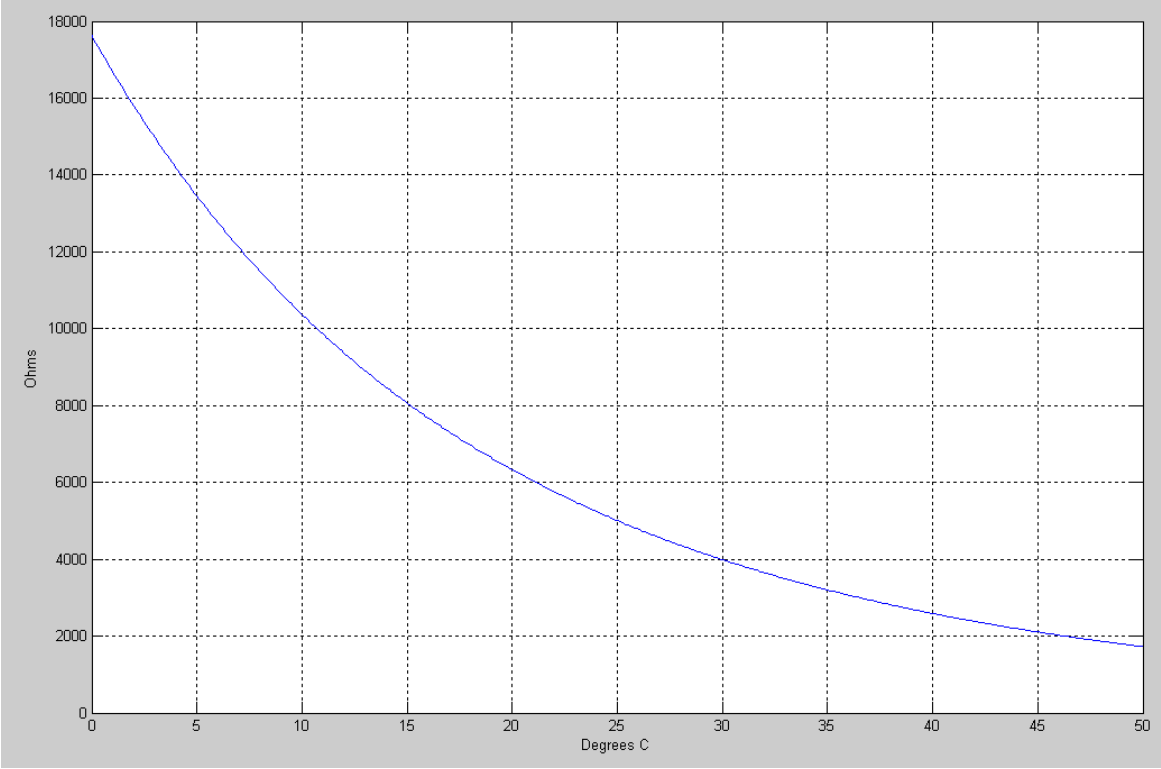
- The temperature when R = 12000 Ohms
- The temperature when R = 6000 Ohms

In Matlab

```
>> T = [0:0.1:50]';
>> R = 5000 * exp(4100 ./ (T+273) - 4100/298);
>> plot(T,R);
>> xlabel('Degrees C');
>> ylabel('Ohms');
```

From the graph

- R = 12,000 T = 7.17 C
- R = 6000 T = 21.1 C



5) Plot the votlage vs. light level for 0 < T < 50. From the graph, determine

- The temperature when V = 4.00 Volts
- The temperature when V = 3.00 Volts

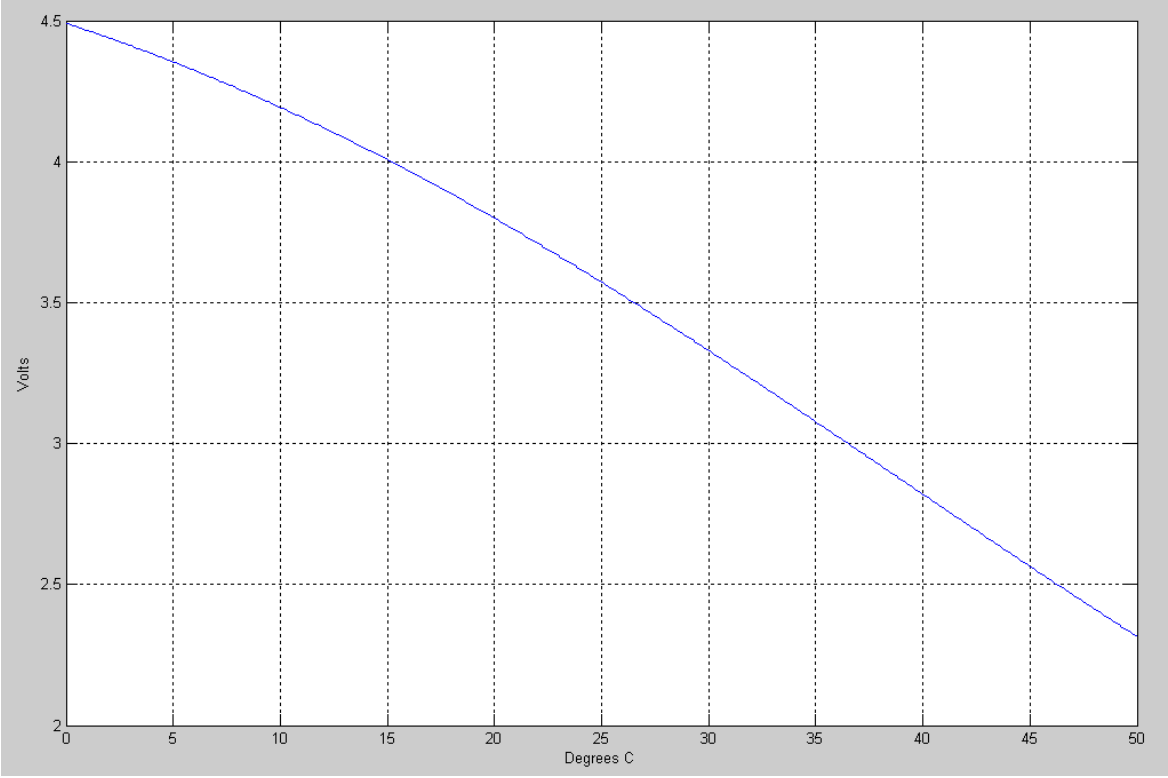
In Matlab

```
>> T = [0:0.1:50]';
>> R = 5000 * exp(4100 ./ (T+273) - 4100/298);
>> V = R ./ (R + 2000) * 5;
>> plot(T,V);
>> grid on
>> xlabel('Degrees C');
>> ylabel('Volts');
```

From the graph

V = 4.00V T = 15.16C

V = 3.00V T = 36.5C



For-Loops

6) A and B are playing a game of dice. For each game

- A rolls four 8-sided dice and takes the sum (A = 4d8)
- B rolls three 12-sided dice and takes the sum (B = 3d12).

Whoever has the higher total wins the game (A wins on ties). Determine the odds that A wins the game using a Monte-Carlo simulation with 100,000 games.

Matlab Code

- Play the game one time
- Once you get that code to work, place in a for-loop and repeat 100,000 times

```
tic
W = 0;
T = 0;
L = 0;
for k=1:1e5
    A = sum(ceil(8*rand(1,4)));
    B = sum(ceil(12*rand(1,3)));
    if(A >= B)
        W = W + 1;
    else
        L = L + 1;
    end
end

disp([W, T, L])
toc
```

Result

```
        A wins       Tie        B Wins
        44878          0       55122

Elapsed time is 1.581196 seconds.
>>
```

- A wins 44.8% of the time
- B wins 55.1% of the time

7) Instead of playing a single game of dice, A and B play a match consisting of 5 games. Determine the odds that A wins the match using a Monte-Carlo simulation with 100,000 games.

Matlab Code:

- Play the game one time (problem #6)
- Once that works, play a 5 game match (add a for-loop)
- Once that works, repeat 100,000 times

```
tic
W = 0;
T = 0;
L = 0;
for k=1:1e5
    Ax = 0;
    Bx = 0;
    for n=1:5
        A = sum(ceil(8*rand(1,4)));
        B = sum(ceil(12*rand(1,3)));
        if(A >= B)
            Ax = Ax + 1;
        else
            Bx = Bx + 1;
        end
    end
    if(Ax > Bx)
        W = W + 1;
    elseif(Ax == Bx)
        T = T + 1;
    else
        L = L + 1;
    end
end

disp([W, T, L])
toc
```

Result:

```
        A wins        Tie       B Wins
        40346           0       59654

  Elapsed time is 7.364045 seconds.
  >>
```

- A wins 40.3% of the time
- B wins 59.6% of the time

While-Loops

8) Instead of playing a match of 5 games, assume the match continues until one player is up two games. Determine the odds that A wins the match using a Monte-Carlo simulation with 100,000 games.

In Matlab

- Play a single game (problem #6)
- Once that works, place in a while loop (keep going until someone is up 2 games)
- Once that works, place in a for-loop and repeat 100,000 times

```
tic
W = 0;
T = 0;
L = 0;
for k=1:1e5
    Ax = 0;
    Bx = 0;
    while(abs(Ax - Bx) < 2)
        A = sum(ceil(8*rand(1,4)));
        B = sum(ceil(12*rand(1,3)));
        if(A >= B)
            Ax = Ax + 1;
        else
            Bx = Bx + 1;
        end
    end
    if(Ax > Bx)
        W = W + 1;
    elseif(Ax == Bx)
        T = T + 1;
    else
        L = L + 1;
    end
end

disp([W, T, L])
toc


       A Wins        Tie      B Wins
       39794           0       60206

Elapsed time is 6.188134 seconds.
```

Net result for win-by-2:

- A wins 39.7% of the time
- B wins 60.2% of the time

9) Instead of playing a match of 5 games, assume the match continues until one player is up five games. Determine the odds that A wins the match using a Monte-Carlo simulation with 100,000 games.

Chance the previous code to play until someone is up by 5

```
tic
W = 0;
T = 0;
L = 0;
for k=1:1e5
    Ax = 0;
    Bx = 0;
    while(abs(Ax - Bx) < 5)
        A = sum(8*rand(1,4));
        B = sum(12*rand(1,3));
        if(A >= B)
            Ax = Ax + 1;
        else
            Bx = Bx + 1;
        end
    end
    if(Ax > Bx)
        W = W + 1;
    elseif(Ax == Bx)
        T = T + 1;
    else
        L = L + 1;
    end
end

disp([W, T, L])
toc
```

Result:

```
        A wins        Tie         B Wins
        26293           0        73707

Elapsed time is 30.538870 seconds.
```

With a win-by-5 series:

- A wins 26.2% of the time
- B wins 73.7% of the time
-