

ECE 111 - Homework #13

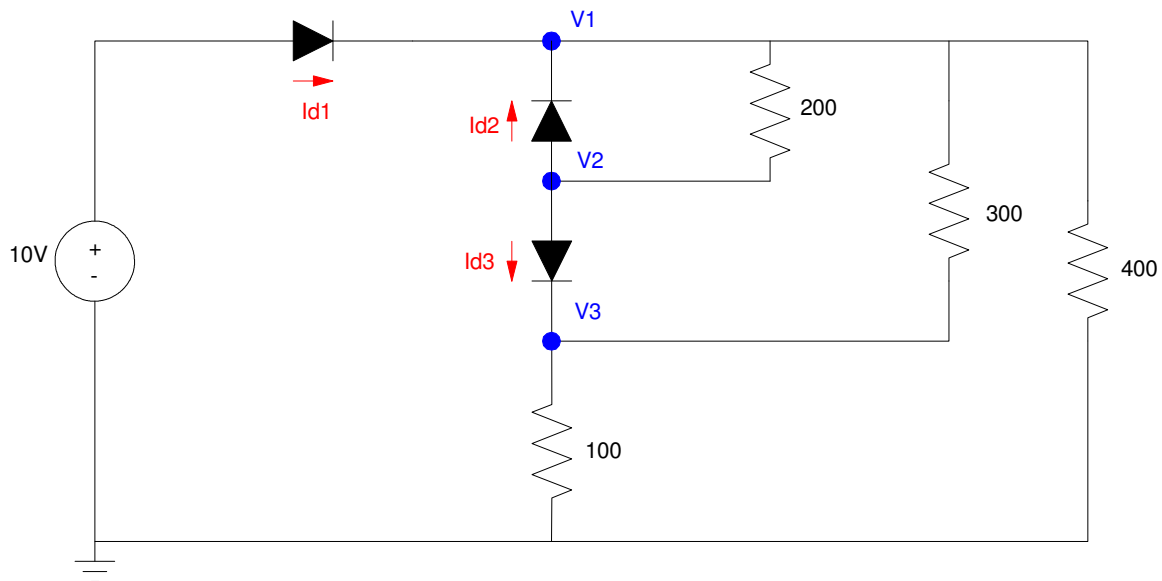
Week #13 - ECE 320 Electronics I. Due November 30th

Please submit as a Word or pdf file to BlackBoard or email to Jacob_Glower@yahoo.com with header ECE 111 HW#13
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Assume the VI characteristics for 1N4004 diodes are:

$$V_d = 0.038 \cdot \ln\left(\frac{I_d}{7.7 \cdot 10^{-11}} + 1\right) \quad I_d = 7.7 \cdot 10^{-11} \left(\exp\left(\frac{V_d}{0.038}\right) - 1\right)$$

1) Write the voltage node equations for the following circuit.



Start with the diode equations

$$I_{d1} = 7.7 \cdot 10^{-11} \left(\exp\left(\frac{10 - V_1}{0.038}\right) - 1\right)$$

$$I_{d2} = 7.7 \cdot 10^{-11} \left(\exp\left(\frac{V_2 - V_1}{0.038}\right) - 1\right)$$

$$I_{d3} = 7.7 \cdot 10^{-11} \left(\exp\left(\frac{V_2 - V_3}{0.038}\right) - 1\right)$$

Now write the voltage node equations

$$-I_{d1} - I_{d2} + \left(\frac{V_1 - V_2}{200}\right) + \left(\frac{V_1 - V_3}{300}\right) + \left(\frac{V_1}{400}\right) = 0$$

$$I_{d2} + I_{d3} + \left(\frac{V_2 - V_1}{200}\right) = 0$$

$$-I_{d3} + \left(\frac{V_3}{100}\right) + \left(\frac{V_3 - V_1}{300}\right) = 0$$

2) Solve using fminsearch and MATLAB

Diode3.m (editor window)

```
function [ J ] = Diode3( z )

    V1 = z(1);
    V2 = z(2);
    V3 = z(3);

    Idss = 7.7e-11;
    nVt = 0.038;

    Id1 = Idss* exp( (10 - V1)/nVt - 1 );
    Id2 = Idss* exp( (V2 - V1)/nVt - 1 );
    Id3 = Idss* exp( (V2 - V3)/nVt - 1 );

    e1 = -Id1 - Id2 + (V1-V2)/200 + (V1-V3)/300 + (V1/400);
    e2 = Id2 + Id3 + (V2-V1)/200;
    e3 = -Id3 + (V3-V1)/300 + V3/100;

    J = (e1)^2 + (e2)^2 + (e3)^2;

    disp([V1, V2, V3, log10(J)]);
    pause(0.1);

end
```

Solving (command window)

```
>> [Z,e] = fminsearch('Diode3',[9.3,2,1])

    9.3000    2.0000    1.0000    2.0620
    9.7650    2.0000    1.0000    2.0619
    9.3000    2.1000    1.0000    4.3487

    9.1824    4.7398    3.9616   -12.2801
    9.1824    4.7398    3.9615   -11.5880

    Z =

        V1        V2        V3
    9.1824    4.7398    3.9616

    e = 5.2465e-013
```

>> 3) Check your results using CircuitLab

- Use 1N4004 diodes

