Massachusetts Institute of Technology
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16.01/16.02 Unified Engineering I, II
Fall 2003

Problem Set 5

Name: _____

Due Date: 10/7/03

	Time Spent (min)
C11	
C12	
C13	
S2	
S3	
S4	
S5	
S6	
Study Time	

Announcements: Thermo Exam on Friday, 9am

Problem C11. (Unified Computers and programming)

1. What is the output of the code fragment in Figure 1?

2. Write an Ada95 program to implement the Euler's 2nd order integration method. Turn in a hard copy of your algorithm and code listing and an electronic copy of your code.

3. Write an Ada95 program to accept 10 numbers from the user and find the average of the numbers. Implement your code using the WHILE – LOOP construct. Turn in a hard copy of your algorithm and code listing, and an electronic copy of your code.

    Hint: Compute the sum every time the user enters a number and the average outside the loop.

```
Count := 1;
for I in 1 .. 10 loop
   if I MOD 2 = 0 then
      for J in 1 .. 10 loop
         Count:= Count + 2;
      end loop;
   else
      for J in 1 .. 5 loop
         Count := Count - 1;
      end loop;
   end if;
end loop;
```

Figure 1. Code Fragment

Problem C12. (Unified Computers and programming)

1. Write an Ada95 program to iteratively compute the factorial of a number (get the number from the user). Turn in a hard copy for your algorithm and code listing, and an electronic copy of your code.

2. Does your program work for all possible inputs? List the instances in which it fails.

3. Write a recursive Ada95 program to compute the first 'N' Fibonacci numbers, where 'N' is user defined. Turn in a hard copy for your algorithm and code listing, and an electronic copy of your code.

Hint: The Fibonacci numbers are the numbers of the series 1, 1, 2, 3, 5, 8, 13, 21, … What is the mathematical formula used to compute the numbers? Do you need more than one function/ procedure?

Problem C13. (Unified Computers and programming)

1. Solve the following recurrence equation using the iteration method. Show all the steps in your derivation.

$$T(n) = \begin{cases} c & n = 1 \\ aT\left(\dfrac{n}{b}\right)\sqrt{} + cn & n > 1 \end{cases}$$

Where a,b,c >=1.

Problem S2 (Signals and Systems)

For the circuit below, solve for all the branch currents and branch voltages, using the following steps. (Note: This problem will be easier once you learn the node method and the loop method. You should do just this one problem the long way.)

1. Label each circuit element with a branch voltage and branch current.

2. Write down Kirchhoff's voltage law for each loop in the circuit.

3. Write down Kirchoff's current law for all the nodes, except one.

4. Write down the constitutive relation for each circuit element.

5. Verify that there are as many equations as unknowns, and solve for all the unknowns. Hint: You should do this in an organized way, as there are a large number of variables.
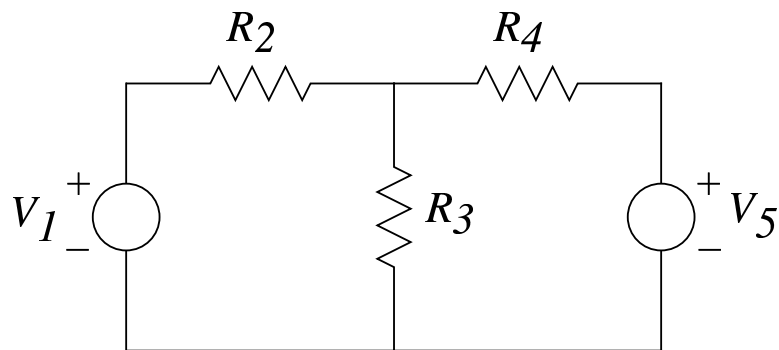
$$V_1 = 4 \text{ V}, \ R_2 = 4 \ \Omega, \ R_3 = 6 \ \Omega, \ R_4 = 12 \ \Omega, \ V_5 = 6 \text{ V}$$

Problem S3 (Signals and Systems)
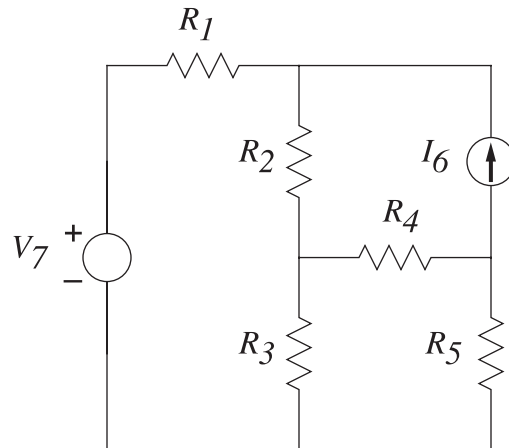
1. For the circuit above, find the branch voltages and branch currents using the node method. The component values are:

$$
\begin{aligned}
R_1 &= 3\ \Omega \\
R_2 &= 2\ \Omega \\
R_3 &= 3\ \Omega \\
R_4 &= 3\ \Omega \\
R_5 &= 1\ \Omega \\
I_8 &= 5\ \text{A} \\
V_7 &= 3\ \text{V}
\end{aligned}
$$

2. Verify that the net power dissipation of the circuit is zero, that is, that

$$
\sum_{n=1}^{7} i_n v_n = 0 \tag{1}
$$

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Problem S4 (Signals and Systems)

For the circuit of Problem S3, find the branch voltages and branch currents using the loop method. Of course, your answer should agree with that of Problem S3.

Problem S5 (Signals and Systems)

Consider the circuit below:
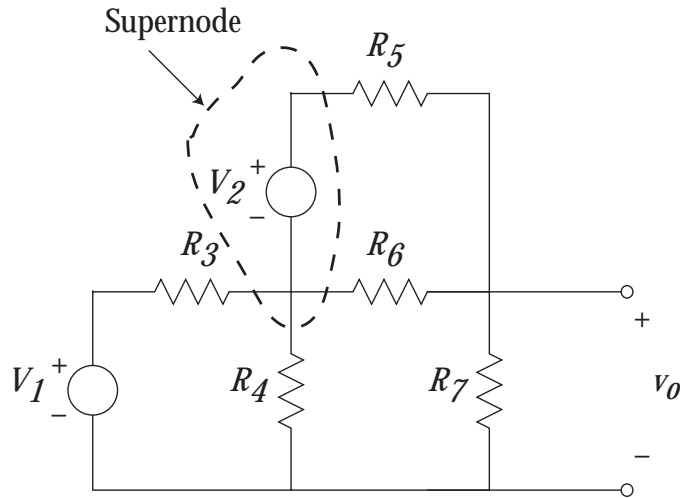
where
$$R_3 = 2 \ \Omega, \quad R_4 = 1 \ \Omega, \quad R_4 = 2 \ \Omega, \quad R_6 = 2 \ \Omega, \quad R_7 = 1 \ \Omega,$$
$$V_1 = 10 \ V, \quad V_2 = 5 \ V$$

Find the output voltage, v_0, using the node method. Note that because the two voltage sources do not have a common terminal, it is not possible to choose a ground node that is the negative terminal of both. As a result, one of the voltage sources will be "floating." Therefore, you will have to use the "supernode" method discussed in recitation. The basic idea is to add the two node equations for the "floating" voltage source. Each node equation has one term for the unknown current through the voltage source. By adding the two equations together, the current terms cancel. In essence, you are applying conservation of charge to the whole dashed region, rather than just to a node.

Note: Feel free to use the loop method to *check* your answer, but use the node method for your final answer.

Problem S6 (Signals and Systems)

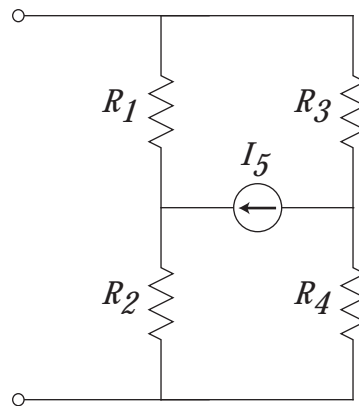Find the Thevinin and Norton equivalent circuits for the circuits below:

1.
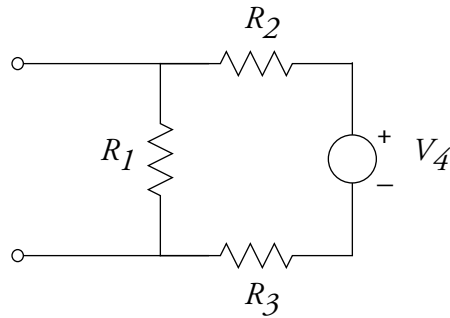
where

$$R_1 = 3 \ \Omega, \quad R_2 = 4 \ \Omega, \quad R_3 = 2 \ \Omega, \quad V_4 = 12 \ V$$

2.

where

$$R_1 = 1 \ \Omega, \quad R_2 = 4 \ \Omega, \quad R_3 = 4 \ \Omega, \quad R_4 = 1 \ \Omega, \quad V_5 = 10 \ V$$