Take-Home Final Examination COT 5405

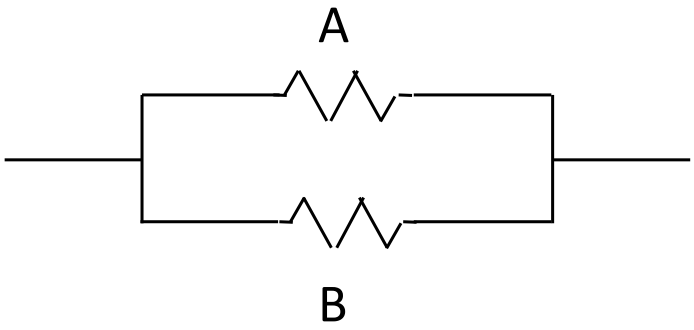
Deadline: Friday December 7 at 4:00pm

Only 1 submission is allowed. No revisions are permitted once the assignment has been submitted.

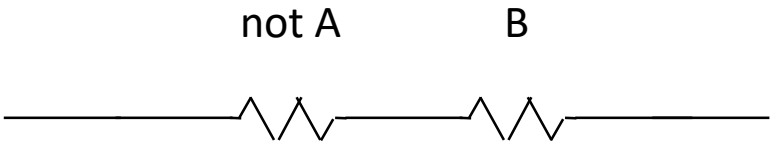
All questions have equal value. No collaboration is permitted. You must submit your own work.

In the mythical land of Far Away, computation is performed using networks of variable-valued resistors. Each resistor is programmed to be high (1 Exa Ohm) or low (1 Femto Ohm) depending on the value of a Boolean literal labeling the resistor. The result of the computation is obtained by computing the overall resistance of the network as high (more than 1 Kilo Ohm) or low (less than 1 Ohm). We will refer to high values as being 1 and low values as being 0 in Boolean logic.

For example, the following network has two resistances. The top resistance is high (1 Exa Ohm) if and only if A is 1. The bottom resistance is high (1 Exa Ohm) if and only if B is 1. You can verify that the network has a high value (more than 1 Kilo Ohm) only if both the resistances are high. If one of the resistances is low (1 Femto Ohm), the network has a low (less than 1 Ohm) resistance. Hence, this circuit implements the Boolean formula (A and B).



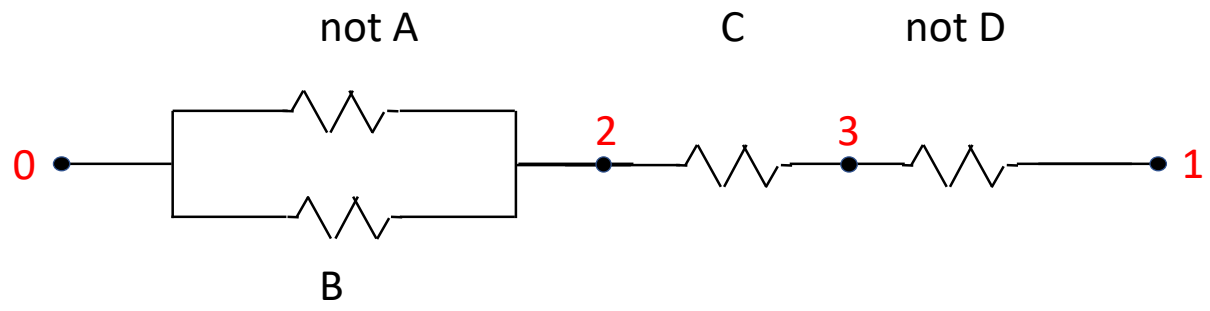
Similarly, the following circuit implements the Boolean formula ((not A) or B):



Question 1: Given a circuit, compute the truth table of the Boolean formula it implements. Run your code on the 5 input files provided to you; document your pseudocode and experimental results in a report. If you used any algorithms or results taught in the class, highlight them in your report.

Each circuit is provide using the following format:
<number of resistances>
<Variable or Negation of Variable labeling the resistor> <node number1> <node number2>
<Variable or Negation of Variable labeling the resistor> <node number1> <node number2>
…
…
<Variable or Negation of Variable labeling the resistor> <node number1> <node number2>

The overall effective resistance of the network is always computed across the terminals or nodes labeled 0 and 1.



For example, the input file shown below represents the circuit above:

```
4
!A      0       2
B       0       2
C       2       3
!D      3       1
```

The output should be a truth table in the following format:

<Variable 1>	<Variable 2>	…	<Variable n>	
<Value of variable 1>	<Value of variable 2>	…	<Value of variable n>	<Output>
<Value of variable 1>	<Value of variable 2>	…	<Value of variable n>	<Output>
….				
….				
<Value of variable 1>	<Value of variable 2>	…	<Value of variable n>	<Output>

Question 2: The citizens of the land of Far Far Away have sought your help in designing network of resistances from Boolean formula. Write a program that reads a truth table and produces the network of resistances to implement the desired formula. Run your code on 5 benchmark files provided to you; document your pseudocode and experimental results in a report. If you used any algorithms or results taught in the class, highlight them in your report.

Each truth table is provide using the following format:

<Variable 1>	<Variable 2>	…	<Variable n>	
<Value of variable 1>	<Value of variable 2>	…	<Value of variable n>	<Output>
<Value of variable 1>	<Value of variable 2>	…	<Value of variable n>	<Output>
….				
….				
<Value of variable 1>	<Value of variable 2>	…	<Value of variable n>	<Output>

For example, the input file shown below represents ((not A) or B):

A	B	
0	0	1
1	0	0
0	1	1
1	0	0

Your output file should be produced in the same format as the input format of Question 1.

Requirement:

1. Solution to Question 1 should produce output in a format accepted by your solution to Question 2. Similarly, solution to Question 2 should produce output in a format accepted by your solution to Question 1.

Permitted simplifying assumptions:

1. You can assume that the end users in the land of Far Far Away are only interested in knowing whether the resistance of the network is high or low; and not the exact value of the resistance.
2. The resistance of the network is always computed across terminals or nodes labeled 0 and 1.
3. You can assume that the network always produces high (more than 1 Kilo Ohm) or low (less than 1 Ohm) effective resistance values, and never ends up producing values in between 1 Ohm and 1 Kilo Ohm.
4. Each resistance is only labeled with either a letter representing a Boolean variable e.g. A or the negation of a letter representing the negation of a Boolean variable e.g. !A.

Additional Points:

Five input test files have been provided for Question 1 and Question 2 each. Five additional files of similar complexity will be used by the course instructor to evaluate each of your submissions. Solving these twenty (20) test files provides full score on the final examination. Failing to solve any test file or any instructor-generated additional test file for a question leads to a 0 score in the corresponding question.

Two (2) other extra-credit test files have been provided for each question; they are named EXTRA1.cir, EXTRA2.cir, EXTRA1.bool, EXTRA2.bool. Solving EXTRA1.cir or EXTRA2.cir test files provides an additional 10% each. Solving EXTRA1.bool or EXTRA2.bool provides an additional 50% each. The solution should be algorithmic and should not be based on a manual analysis of the provided input files. A solution based on manual analysis will fetch 0 points.