# CS 131 – Fall 2019, Prof. Tsourakakis
## Assignment 1 must be submitted by Friday September 13, 2019 5:00pm, on Gradescope.

All of our homeworks will require short proofs. The points for a given exercise are equally distributed among the subquestions. In writing up proofs, try to follow the style in our textbooks and make sure your reasoning flows logically from one statement to another. You should edit and revise your proofs to make sure they are clear and concise. Typesetting your solutions in LaTeX(www.latex-project.org) is preferred (and streamlines revisions), but you may also submit written solutions. The LaTeXsource for our assignments is posted online.

**Problem 1.** (20 points) Analyze the logical forms of the following statements.

**a)** Mary and Kevin are not both in CAS B12.

**b)** Mary and Kevin are both not in CAS B12.

**c)** Either Mary or Kevin is not in CAS B12.

**d)** Neither Mary nor Kevin is in CAS B12.

**Problem 2.** (24 points) Analyze the following deductive arguments and analyze their logical forms, specifying the premises and conclusions in propositional logic. Use truth tables to argue whether the reasoning is valid or invalid.

**a)** Jane and Pete won't both win the math prize. Pete will win either the math prize or the chemistry prize. Jane will win the math prize. Therefore, Pete will win the chemistry prize.

**b)** Either John or Bill is telling the truth. Either Sam or Bill is lying. Therefore, either John is telling the truth or Sam is lying.

**c)** If sales go up then the boss will be happy. If expenses go up then the boss won't be happy. Therefore, sales and expenses will not both go up.

**Problem 3.** (24 points) Demonstrate the following equivalences and tautologies.

**a)** Use truth tables to show that $P \leftrightarrow Q$ is equivalent to $(P \wedge Q) \vee (\neg P \wedge \neg Q)$.

**b)** Use logical deductions (i.e., apply the Laws) to show that $(P \to Q) \vee (P \to R)$ is equivalent to $P \to (Q \vee R)$.

**c)** Use a method of your choice to show that $(P \to Q) \vee (Q \to R)$ is a tautology.

**Problem 4.** (12 points) You recently started working in VLSI company, and your first task is to construct a combinatorial circuit that produces from input bits $p, q, r$ the desired output $((\neg p \vee \neg r) \wedge \neg q) \vee (\neg p \wedge (q \vee r))$. You can use *OR* gates, *AND* gates, and inverters.

**Problem 5.** (20 points) Suppose there are signs on the doors to two rooms. The sign on the first door reads "In this room there is a lady, and in the other one there is a tiger"; and the sign on the second door reads "In one of these rooms, there is a lady, and in one of them there is a tiger." Suppose that you know that one of these signs is true and the other is false.

Behind which door is the lady? Explain your reasoning.

*Hint:* You may use propositional logic, but you do not need to. Argue in few lines.