

**UNIVERSITY OF CALIFORNIA**  
**College of Engineering**  
**Department of Electrical Engineering and Computer Sciences**

**EECS 249**  
**Fall 2012**

**A. Sangiovanni-Vincentelli**  
**P. Nuzzo**

**Homework 4**  
**Due Tuesday, November 27, 2012**

**General remark:** since we will mostly be dealing with design problems throughout this class, an answer to a homework problem may not necessarily be right or wrong. Grade is established mostly based on the reasoning that you follow while developing your solution. Therefore, make sure that you justify all your claims. You can use any kind of sources as long as you include references.

**HW4 focuses on concepts of Contract-Based Design and its application.**

**1. Basic properties of contracts.** Use the definitions and properties introduced by the meta-theory of contracts seen in class to prove the following properties of contracts:

- a) *Contract associativity and commutativity.* For all contracts  $C_1, C_2, C_3$  and  $C_4$ , if  $C_1$  and  $C_2$  are compatible,  $C_3$  and  $C_4$  are compatible, and  $C_1 \otimes C_2$  is compatible with  $C_3 \otimes C_4$ , then  $C_1$  is compatible with  $C_3$ ,  $C_2$  is compatible with  $C_4$ ,  $C_1 \otimes C_3$  is compatible with  $C_2 \otimes C_4$ , and

$$(C_1 \otimes C_2) \otimes (C_3 \otimes C_4) = (C_1 \otimes C_3) \otimes (C_2 \otimes C_4).$$

- b) *Contract distributivity.* If the following contract compositions are all well-defined, then the following holds:

$$[(C_{11} \wedge C_{21}) \otimes (C_{12} \wedge C_{22})] \preceq [(C_{11} \otimes C_{12}) \wedge (C_{21} \otimes C_{22})].$$

Why are the above properties important for system design? How could they be used?

**2. Application of contracts.** Consider the design and modeling problem you are examining for your class project and provide a detailed example of usage of *horizontal* and *vertical contracts* in your context. Which design or analysis steps would mostly benefit from the introduction of contracts in your methodology? What could be the potential overhead?