# System-Level Design
2.01.334, Summer 2024

## Exercise 1
## Methodologies, Models, Languages

**Assigned:** April 8, 2024
**Due:** April 15, 2024

## General Instructions

1. Please submit your solutions via mail to your advisors (mail addresses can be found at the end of this document). Submissions should include a single typewritten PDF file with the writeup and a single Zip or Tar archive for any supplementary files (e.g. source files, which has to be compilable by simply running `make` and should include a README file with instructions for running each model).

2. You may discuss the problems with your classmates but make sure to submit your own independent and individual solutions. You are allowed to work in groups with up to three members. In this case, please put the full names of all three group members on the cover page of you submitted solutions.

3. Some questions might not have a clearly correct or wrong answer. In general, try to write down your arguments and reasoning how you have arrived at your solutions.

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## Task 1: System Design

During design space exploration as part of the system design process, the target system architecture and its key architectural parameters are decided on. These design decisions have a major influence on the final design quality metrics such as (i) performance, (ii) power, (iii) cost, and (iv) time-to-market:

**a)** Briefly discuss how the following target platform styles rate in relation to each other in terms of the metrics listed above:

- A pure software solution on a general-purpose processor
- A general-purpose processor assisted by a custom hardware accelerator/co-processor
- A general-purpose processor and a specialized processor (DSP or ASIP)

**b)** Try to sketch a potential simple strategy for exploring the design space for a given application under a given set of constraints/requirements.

## Task 2: Languages

**a)** Why are sequential programming languages (e.g. C/C++/Java) considered to be insufficient for embedded system specification and design?

**b)** Why are hardware design languages (e.g. VHDL/Verilog) considered to be insufficient for embedded system specification and design?

**Task 3: Language Concepts**

We have discussed the concepts of synthesizability, orthogonality and separation of concerns in languages.

   **a)** What are the requirements for languages to be synthesizable?

   **b)** Briefly define what orthogonality is? What is separation of concerns?

   **c)** Try to show an example other than the ones discussed in class of non-orthogonal concepts or constructs in a language.

   **d)** Name two concerns that should be separated as they cover orthogonal aspects? Show a short code excerpt that demonstrates a non separated code and code that separates these concerns (in C/C++/SpecC/SystemC or similar).

**Task 4: Specification**

Writing a good specification model is essential to a successful design process. One important characteristic of a specification model is to be free of implementation detail. Please briefly outline why this is important with respect to the top down design flow.

**Task 5: Design Methodology**

   **a)** Compare and contrast a top-down, bottom-up and meet-in-the-middle design methodology.

   **b)** What type of methodology is a platform-based approach? Describe a platform-based methodology and flow.

   **c)** Why do we perform computation design before communication design in the SpecC/SCE methodology?

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**Administrative**

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