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1. **(15 pts)** Briefly explain the concept of virtual machines and its applications on cloud computing.

2. **(30 pts)** Explain the following processor design concepts. For each one, give an example commercial product that falls into this category.
   - (a) Instruction-level parallelism
   - (b) Thread-level parallelism
   - (c) Data parallelism.
   - (d) Superscalar processor
   - (e) VLIW processor

3. For each of the processor style listed below, give examples to show how a compiler can do to improve the program execution performance. In your answer, you should give an example program and show how the compiler transforms the program to reduce program execution time.
   - (a) **(8 pts)** A single pipelined processor
   - (b) **(8 pts)** A VLIW processor
   - (c) **(8 pts)** A processor associated with a data cache.

4. **(16 pts)** Give an example, with a program fragment and the pipeline behavior, to explain why branch prediction may improve the performance of a pipelined processor.

5. Discuss the concepts about Moore's law by answering the following questions.
   - (a) (**5 pts**) What is Moore's law?
   - (b) (**10 pts**) What's the impact to global economy if the scaling trend of Moore's law stops? (There is no clear answer to this question but I want to hear your own opinion.)

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