System Design Techniques

1. When you "design" a computer system (hardware or software), what are some common goals that you may have as a designer?

2. What is meant by performance metric? What are resource constraints? How do the two interact? Give some examples.

3. What are some common examples of resources to consider when designing a computer system?

4. What are some key (a) performance metrics, and (b) resource constraints when designing the following systems?
   A. CPU
   B. Memory
   C. Network
   D. Storage
   E. A supercomputer

5. What is a "balanced" system? Why is balance important?

6. What are the different ways one can achieve balance? What are the goals of each approach?

7. Explain each of the following concepts and the tradeoffs it offers, with examples
   1. Multiplexing
   2. Pipelining and Parallelism
   3. Batching (versus multi-programming)
   4. Caching (or exploiting locality)

8. What is the "80/20 rule"? (Why is it not the "90/10 rule"?!) Explain with examples.

9. Explain the notion of binding and indirection using virtual memory (or domain names or email aliases or something else) as an example.

10. What is the difference between abstraction and virtualization?

11. What are the benefits/drawbacks of hard state versus soft state design? Examples?

12. How do the following file system components apply the system design principle of "making the common case fast"?
    (a) File system cache (page cache)
    (b) Log-structured file system
    (c) TLB
    (d) Unix i-node

13. What is hysteresis? Explain <u>how</u> the page-out/page-in mechanism in the OS uses hysteresis <u>and why</u>?

14. If you were to apply the principle of separating data plane and control plane to OS design, what OS components would you move out of the kernel to user space and why?

15. Suppose you are asked by your company to redesign a computer that they sell. Their current product on sale has a really fast processor, moderately fast system bus, and a really slow disk. How would you balance the computer to improve
    A. Performance?
    B. Cost?
    C. Both performance and cost?

16. What are the (a) performance metrics, and (b) resource constraints when designing the following systems?
    D. CPU
    E. Memory
    F. Network
    G. Storage
    H. A supercomputer