1. (10 pts.) Study the part of the bottom paragraph on page 2 of Saltzer & Kaashoek Ch. 9 which discusses a toaster purchase. Draw two sequence diagrams that illustrate (1) buying the toaster successfully, and (2) a failing toaster purchase that does no harm because of all-or-nothing atomicity. Your diagrams must mention all the events mentioned in the discussion.

2. (10 pts.) Study the rest of that paragraph that discusses errors due to race conditions. Draw two sequence diagrams that illustrate (1) how both customers can receive a confirmation even though only one toaster is in stock, and (2) how this error is prevented when before-and-after atomicity is enforced.

3. (10 pts.) How do all-or-nothing and before-and-after atomicity together provide a very strong form of modularity? What properties of an atomic action, also known as a transaction, are of interest to operating or hardware system user or database administrator? What properties of an atomic action must an OS, hardware or database implementor be aware of in order to implement them so they provide modularity?

4. (5 pts.) Suppose there are 10 concurrent activities where 5 are done in program order by one process and the other are done in program order by a second process. How many different potential real time sequences are possible? Express your answer both as a binomial coefficient and as a number.

5. (5 pts.) Repeat the above problem for 15 concurrent activities by three concurrent processes with 5 program ordered activities each. Express your answer as a number and explain how you got it. It is a multinomial coefficient.

6. (5 pts.) Why do the Saltzer & Kaashoek use the terms all-or-nothing atomicity and before-and-after atomicity even though there are some shorter, equivalent terms in the database and hardware literatures?

7. (9 pts.) Modularization involves hiding the details of something. What is the thing whose details are hidden in each example? (1) Data abstraction. (2) Client-server organization. (3) Atomicity.

8. (10 pts.) Illustrate and explain with a sequence diagram the page fault scenario discussed on pages 9-10 to 9-11.

9. (1 pt.) Under all-or-nothing atomicity, are the “benevolent side effects” of a transaction rolled back when the transaction fails?

10. (5 pts.) What is the difference between simple locking and two-phase locking, all discussed on page 9-70 to 9-73.

11. (5 pts.) Why is the sequence at the bottom of 9-73 (1) prevented by two-phase locking? (2) But, why does it always has a correct result?

12. (10 pts.) Use a sequence diagram to illustrate the livelock situation involving Alphonse and Gaston contending for the Apple and Banana in a system where deadlock is detected and removed, which is described in the middle of page 9-78.