Warm-up (15 points)
1. (5 points) Write your name and student-id on your blue book.
2. (10 points) What does it mean for a program to be a transaction? (Definition of the term “transaction” is sufficient as an answer.)

Query Processing (40 points)
In preparation for you going home, I contacted Santa Claus for a list of gifts he is bringing each of the csci485 students. He had re-organized his North Pole office with a relational database management system (DBMS) and provided me with remote-access to his system. I found two relevant tables: Person (pid, name, age, good-or-bad, gift-id) and Gifts(gift-id, price, quantity). Santa’s wife explained that she has been looking up our web site on query processing and has analyzed Santa’s DBMS. She said there are 100,000 rows in the Person table and 10,000 rows in the Gifts table (t(Person)=100,000 and t(Gifts)=10,000). She also said 10 rows of Person table fit per disk page and 20 rows of Gifts table fit per disk page. Thus, P(person) = 10,000 and P(Gifts)=500.

a. (20 points) What is the cost of joining the Person and Gifts table using the gift-id attribute? Assume the system uses a tuple nested loop algorithm for the join operator.

b. (20 points) What is the estimated number of records produced by the relational select operator that retrieves all those Gifts with a price tag of $100,000? You may assume there are 100 unique prices in the Gifts table, v(price, Gifts)=100.

Concurrency control (30 points)
(10 points) With multi-granularity locking, the locking protocol supports the following lock modes: Shared (S), eXclusive (X), Intent to Share (IS), Intent to eXclusive (IX), and Shared with Intent to eXclusive (SIX).

a. Describe the SIX lock mode.
b. Provide an example to motivate the SIX lock.

Assume 3 transactions are executing in a transaction processing system simultaneously. Transaction T1 arrives before T2, and Transaction T2 arrives before T3.

a. (10 points) With a lock-based protocol, is it possible for T3 to observe the updates performed by T1?
b. (10 points) With a time-stamp based protocol, is it possible for T2 to observe the updates performed by T1?

Crash recovery (10 points)
(10 points) When a transaction processing system employs “logging with deferred database modification” as its crash-recover mechanism, what actions does it perform when recovering from a system crash? (To simplify the question, assume no checkpoints.)