Final

Note

This is an open-book exam. You may consult any books, papers, or notes, but discussion is strictly forbidden.

Problems

1. Please answer the following questions.

   (a) The Iterator pattern is implemented by C++ templates in the textbook. Please give one advantage and one disadvantage of the template implementation. (10 %)

   (b) Consider the `FilteringListTraverser` template.

   ```cpp
   template <class Item>
   class FilteringListTraverser {
   public:
     FilteringListTrverser (List<Item> *aList);
     bool Traverse ();
   protected:
     virtual bool ProcessItem (const Item &) = 0;
     virtual bool TestItem (const Item &) = 0;
   private:
     ListIterator<Item> _iterator;
   };
   ```

   Please write a C++ pseudo code to print all even numbers in an integer list up to the first 0. For instance, if the list `1, 4, -3, -8, 2, 0, -5, 6` is given, your code should print `4 -8 2 0`. (5 %)

2. In a secure system, user identifiers and their passwords should be kept separately and consistently. That is, when one is modified by administrators, the other must be changed properly. You are going to design a system to make sure the consistency of both by the Mediator pattern. Please answer the following questions in pseudo C++ or Java code.

1

(a) Please write an abstract base class for lists. (5 %)

(b) Please write interfaces for `UserIdList` and `PasswordList`. (5 %)

(c) Please implement your system class `SecureSystem` as the director in the Mediator pattern. (5 %)

3. Prove the following by *Natural Deduction*:

(a) From "$\Gamma, A, B, C \vdash D$", one can deduce "$\Gamma, A \land B \land C \vdash D$". (5 %)

(b) $\Gamma, s = t \vdash t = s$ (Symmetry of Equality) (5 %)

(c) $\Gamma, s = t, t = r \vdash s = r$ (Transitivity of Equality) (5 %)

4. This problem refers to the Class Diagram Example in Chapter 7 of the UML 2.0 OCL Specification, shown below.
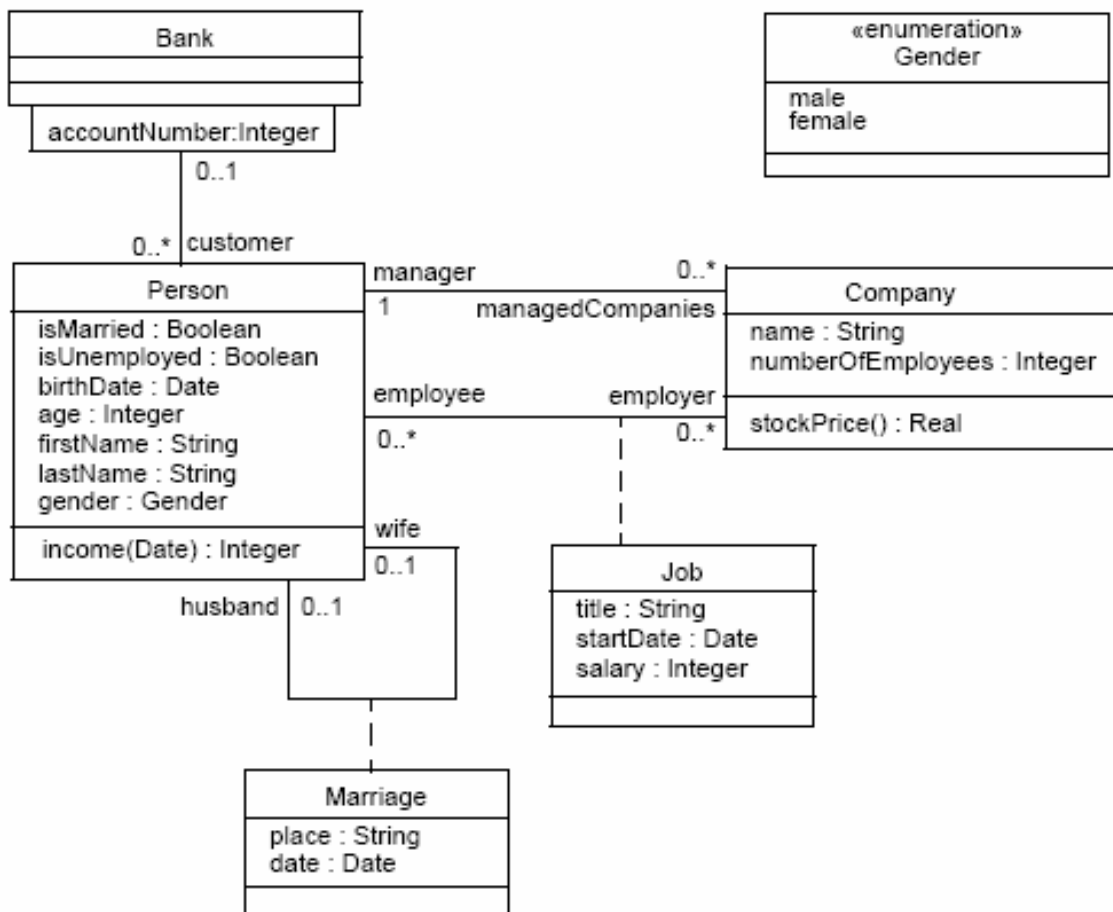
Write an OCL specification for each of the following requirement descriptions. Please make assumptions wherever necessary.

(a) A marriage must be between two people of age at least 18 from January 1, 2007. (5 %)

(b) Any company with 5 employees or more must hire a female employee. (5 %)

(c) The (annual) income of a person (counted on a particular date) should be the sum of all salaries from the person's jobs (on that particular date). (5 %)

5. For each of the following ω-regular expressions, draw an equivalent Büchi automaton.

(a) $b^*(aa)^\omega + a^*(bb)^\omega$ (5 %)

(b) $(a+b)^*(aa+bb)^\omega$ (5 %)

6. For each of the following temporal formulae, draw an equivalent Büchi automaton, assuming the alphabet is {pq,p~q,~pq,~p~q}.

(a) $\Diamond p \wedge \Diamond q$ (10 %)

(b) $\Diamond \Box p \rightarrow \Box \Diamond q$ (10 %)

7. Consider the Promela code below. Please give a temporal formula and the definitions of relevant propositions for proving its liveness property, namely any user that is trying to enter the critical section will eventually succeed. (10 %)

```
mtype { p , v };

chan sema = [0] of {mtype};

active proctype Dijkstra()
{ byte count = 1;

end:
  do
  :: (count==1)  ->  sema!p;  count = 0
  :: (count==0)  ->  sema?v;  count = 1
  od
}

active [3] proctype user()
{ do
```

```
   ::
try:
     sema?p;      /* enter */
critical:  skip;   /* leave */
     sema!v;
   od
}
```