

**Faculty of Arts and Science  
University of Toronto**

**Midterm Test**

**Department:** Computer Science  
**Instructor:** John Mylopoulos  
**Date and Time:** 6:10pm, Thursday  
February 24, 2000

**Conditions:** Closed book  
**Duration:** 50 minutes

**This test counts for 20% of the final grade**

**Name:**

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(Please underline last name)

**Student Number:**

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**1. [Short Questions; 30 marks total]**

(a) [Feasibility Study – 5 marks] What is the present value of \$1,000 one year from now, assuming a 10% discount rate?

$$\text{Present value} = \$1,000 * 1/(1+0.1) = \$1,000 * 1/1.1 = \$909.09$$

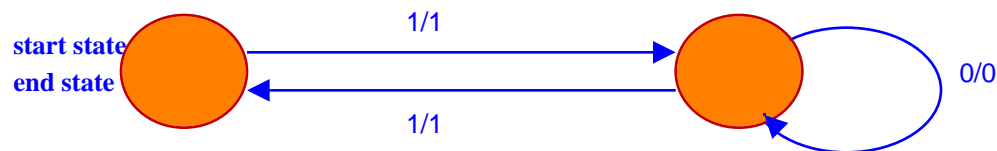
**(Full marks for any of the above)**

(b) [Feasibility Study – 5 marks] What is *payback analysis*? Explain briefly how it works.

**Payback Analysis: how long will it take (usually, in years) to pay back the project costs, calculated as follows:**

$$\text{Total costs (initial + incremental) - Yearly return (or savings)}$$

(c) [Finite State Machines – 5 marks] For what sequences of inputs, consisting of 0's and 1's, does this finite state machine end in the end state? What is the output sequence for such input sequences?



**For the empty string, or a string starting with 1, followed by zero or more 0's, and ending with a 1, or a 10...01 string repeated any number of times ( or (10\*1)\*)**

**Output is the same as the input string.**

(d) [Entity-Relationship Model; keys – 5 marks] Define a key for the COURSE entity shown below, assuming that

- a course can be given multiple times during a term,
- each section has a single instructor,
- an instructor can teach multiple sections of the same course

COURSE(name, title, dept, instructor, section, year, semester, enrolment#)

**Solution:**

COURSE(name, title, dept, instructor, section, year, semester, enrolment#)

**[Short Questions; continued]**

(e) **[Entity-Relationship Model; normal forms – 10 marks]** Consider the BUILDING entity used for a municipal database with the following key and attributes:

BUILDING(street, street#, city, ownerName, ownerAddress, propertyTax)

This entity is already in first normal form (1NF). Is it in 2NF and in 3NF? Explain your answer, and if not already in 2NF or 3NF, put it in 3NF. You may assume that:

- ownerName functionally depends on street, street#, city
- propertyTax functionally depends on street, street#, city
- ownerAddress functionally depends on ownerName

**It is in 2NF because non-key attributes depend on the whole key.**

**It is not in 3NF because ownerAddress depends on ownerName; here is a 3NF version of the entity:**

**BUILDING(street, street#, city, ownerName, propertyTax)**  
**OWNER(ownerName, ownerAddress)**

**2. [Data Flow Diagrams; 30 marks]**

In parts (a) and (b) of this question you are asked to draw context and level 0 data flow diagrams for the case described below. Do your scratch work on scratch pages provided in the back of this exam book before drawing your final answers. Data flow diagrams which are impossible to interpret because of all the scratching out and changes are less likely to be treated generously.

**The Blood Bank Testing Unit.** This is one unit within the College Street Red Cross Blood Donor Centre. On the day following a blood donation, the Blood Bank unit tests all blood for blood type and potential viral agents. They send the results of these tests to the Processing Office (another unit of the Centre). For each tested blood unit, they fill out a form which lists the blood unit number, the blood type, the date and the results of the test. If the tests indicate that the blood may be contaminated with a viral agent, the blood unit is destroyed. This is indicated on the test form.

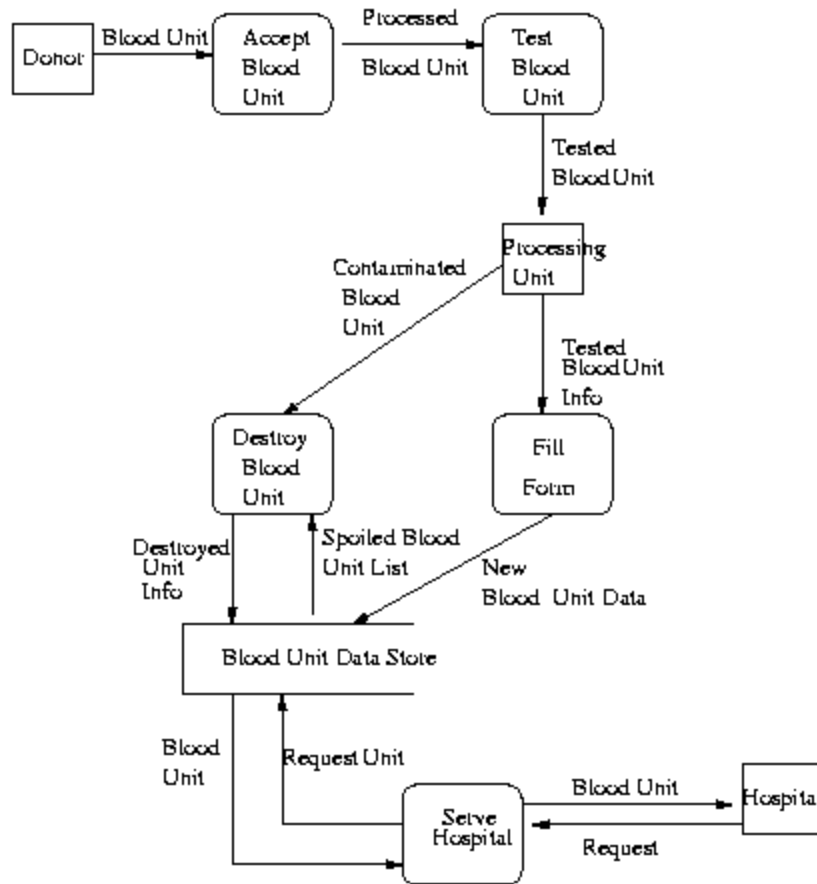
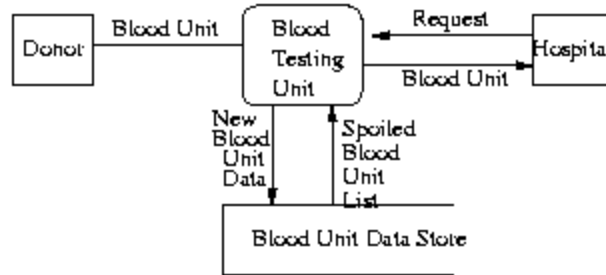
Blood units have a limited shelf life. The Blood Bank receives a list every day of those units which have exceeded their shelf life. These are discarded and the list sent back to the Processing Office with a signed indication of the disposal of the units.

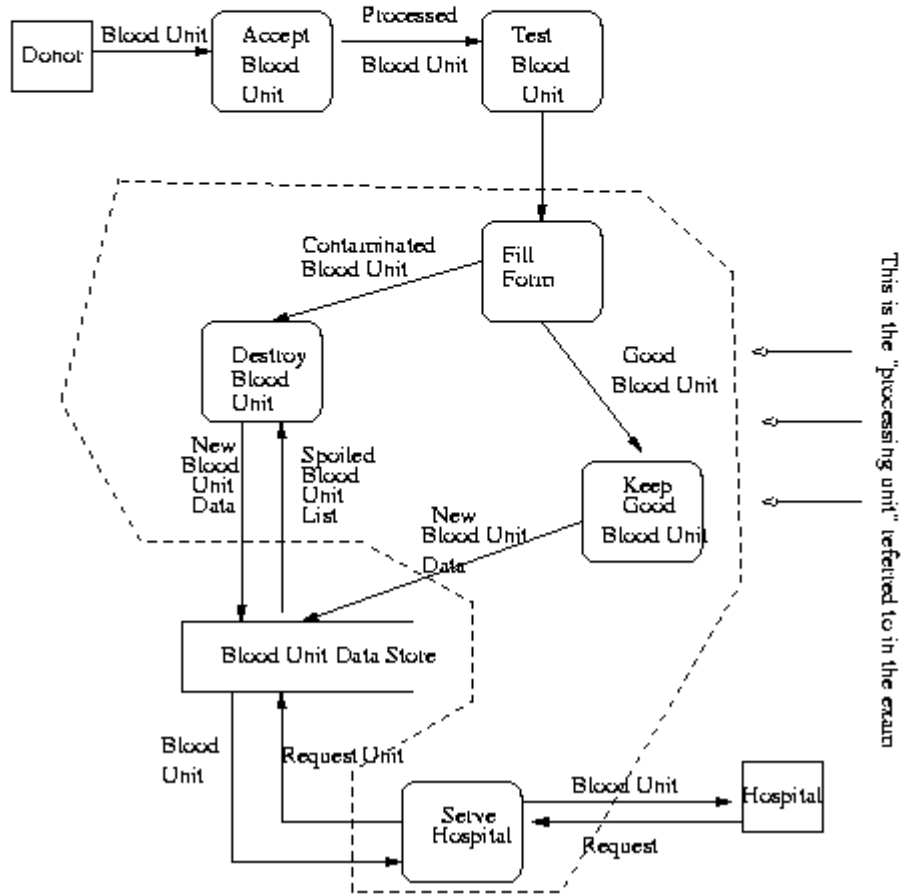
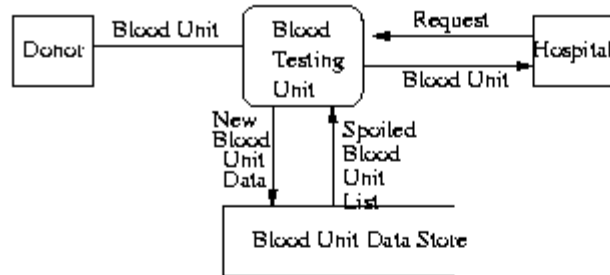
The Blood Bank also distributes blood to various hospitals requesting blood. Requests usually come in for specific blood types. The Blood Bank prepares refrigerated containers of these units and distributes them to the hospital vans when they arrive to pick up their supply. The Blood Bank receives a listing for each hospital and the specific units of blood to supply to the hospital from the Processing Office. The order is printed in triplicate. When the order is filled, the lab technician signs the order and returns a copy to the Processing Office. A copy of it travels with the blood to the requesting hospital. The final copy is kept in the Blood Bank records but discarded after one year.

**(a) [10 marks]** Draw a context data flow diagram for the Blood Bank Testing Unit System.

**(b) [20 marks]** Draw a level 0 data flow diagram for the Blood Bank Testing Unit System.

Two solutions:

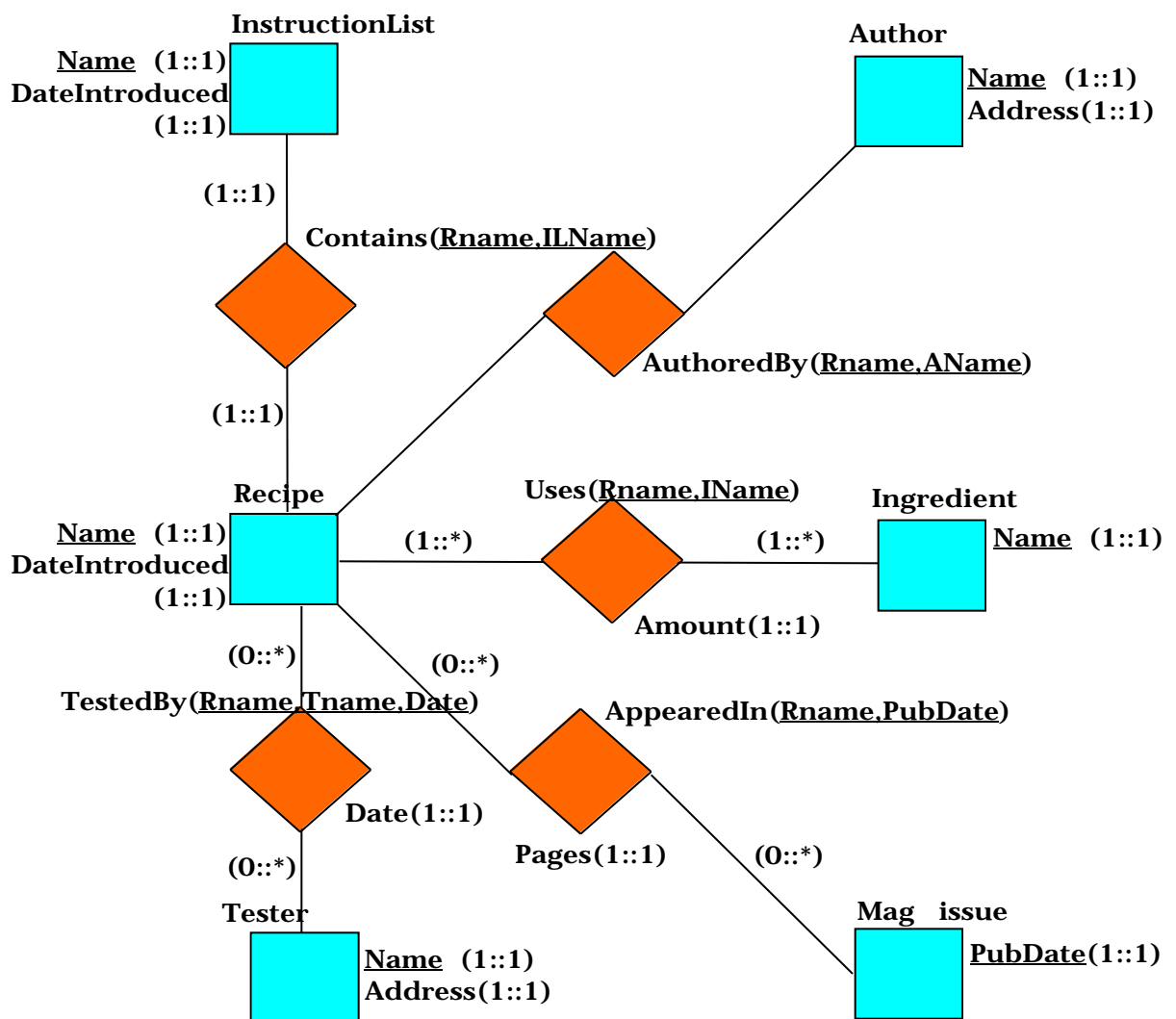




3. [Entity-Relationship Diagrams, 20 marks]

The Gourmand Food and Wine Magazine keeps track of each recipe it tests and publishes in its highly acclaimed publication, *Gourmand: The Magazine of Heavy Eating*. They keep each recipe in a file folder which is filed alphabetically by the recipe name. Each entry of the recipe file folder lists the ingredients, instructions and author of every recipe they have published. In addition, each entry has information on the date of testing, the tester, all dates of publication and the title of the article where the recipe appeared (a recipe may be published several times).

Give an entity-relationship diagram for the information stored in the Gourmand recipe file. Show clearly keys for all entities and relationships, also cardinalities for all relationships.



(Scratch paper)

(Scratch paper)