April, 2007

Software Design and Development Engineer Examination
(Afternoon, Part 2)

Questions must be answered in accordance with the following:

Question No.	Q1
Question Selection	All subquestions are compulsory
Examination Time	16:00 - 17:00 (60 minutes)

Instructions:

1. Use a pencil. If you need to change an answer, erase your previous answer completely and neatly.   Wipe away any eraser debris.

2. Mark your examinee information and test answers in accordance with the instructions below.   Your test will not be graded if you do not mark properly.   Do not mark or write on the answer sheet outside of the prescribed places.

    (1) **Examinee Number**

    Write your examinee number in the space provided, and mark the appropriate space below each digit.

    (2) **Date of Birth**

    Write your date of birth (in numbers) exactly as it is printed on your examination admission card, and mark the appropriate space below each digit.

    (3) **Answers**

    Write each answer in the space specified for that question.

    Write your answers clearly and neatly.   Answers that are difficult to read will receive a lower score.

> **Do not open the exam booklet until instructed to do so.**
> **Inquiries about the exam questions will not be answered.**

Company names and product names appearing in the test questions are trademarks or registered trademarks of their respective companies. Note that the ® and ™ symbols are not used within.

Q1. Read the following description of a library system, and then answer Subquestions 1 through 7.

There are two or more libraries in City H. City H is developing a library system to be shared by all of its libraries. The library system consists of collection management, user management, check-out, and check-in functions. Although check-in and check-out operations are carried out at the counter of the library that owns the book or magazine in question, the data that is managed by the library system is shared by all the libraries. The requirements for the library functions are given below.

[Collection management functions]

(Library cataloging)

When a library acquires a magazine or a book (hereinafter jointly referred to as "item"), a library clerk registers the item's data in the library catalog and issues a label to be attached to the item. The label has a barcode printed at the library. The barcode gives the item number that is assigned to the item; this number is unique among all of the libraries. The clerk attaches the label to the item and places the item on the shelf.

The item data for magazines consists of item number, owner library code (the library code of the library that owns the book), magazine title, publisher, volume number, issue number, publication date, acquisition date, disposal date, catalog price, and rare item classification. The item data for books consists of item number, owner library code, book title, author name, publisher, ISBN, book classification number, publication date, acquisition date, disposal date, catalog price, and rare item classification.

ISBN stands for International Standard Book Number, a unique key assigned to each book to identify it.

The "rare item classification" indicates the items that should be permanently stored such as municipal archives and rare books, distinguishing them from ordinary items that may be disposed of according to the library's disposal rules.
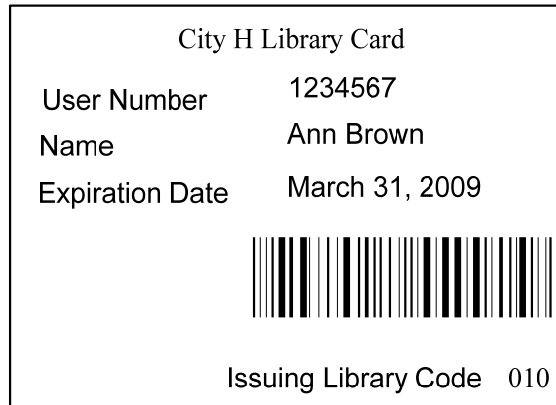
(Item disposal)

Items that have not been lent for the past 5 years (excluding those which are to be stored permanently) must be disposed of at the end of every fiscal year. At that time, the disposal date must be logged in the library catalog.

[User management functions]

(User registration)

A user who wants to make use of City H's libraries submits an application to a library for library use and then receives a library card (see Figure 1). The library card is valid at all of

the libraries in the system. The library card is assigned a user number that is unique within the library that issued the card. The user number is printed on the library card together with a barcode that encodes the issuing library code and the user number. The period of validity of the library card extends from the registration date to three years later on the last day of the month of registration.   The user data is stored in the user catalog.

```
┌─────────────────────────────────────┐
│           City H Library Card         │
│                                       │
│  User Number        1234567           │
│  Name               Ann Brown         │
│  Expiration Date    March 31, 2009    │
│                                       │
│         ║▌║▌║▌║▌║▌║▌║▌║▌║▌             │
│                                       │
│         Issuing Library Code   010    │
└─────────────────────────────────────┘
```

Fig. 1   Library Card

(User deregistration)
Users with expired cards must be removed from the user catalog. The library system cannot renew library cards.

[Check-out functions]

(Lending)
A user selects a desired item from the shelf and brings it to the check-out counter together with his/her library card. The clerk at the counter scans both the barcode on the library card and the barcode on the item's label and, if the user card proves to be within the validity period, registers the item in the loan catalog for check-out.   One user can have up to five items in total checked-out from all of the libraries combined in any given time period. The due date is two weeks after the check-out date.

[Check-in functions]

(Returning)
When returning an item, a user returns it to the library's check-in counter or places it in a book drop.   The clerk at the counter scans the barcode on the label attached to the returned item, registers the item in the loan catalog for check-in, and generates a returned item list. Subsequently, the item is returned to the correct shelf.

(Item recall)

At the beginning of every month, the library prints and mails recall notices to users who have items that were overdue at the end of the preceding month. These notices urge the users to promptly return the items. The number of recall notices issued to each user is recorded in the loan catalog.

Mr. B, who is in charge of developing the library system, prepared a DFD for library operations (see Figure 2). The DFD shown in Figure 2 is assumed to have no data for specifying search keys. It is also assumed that the user and item numbers are generated and assigned during the course of registration processing.
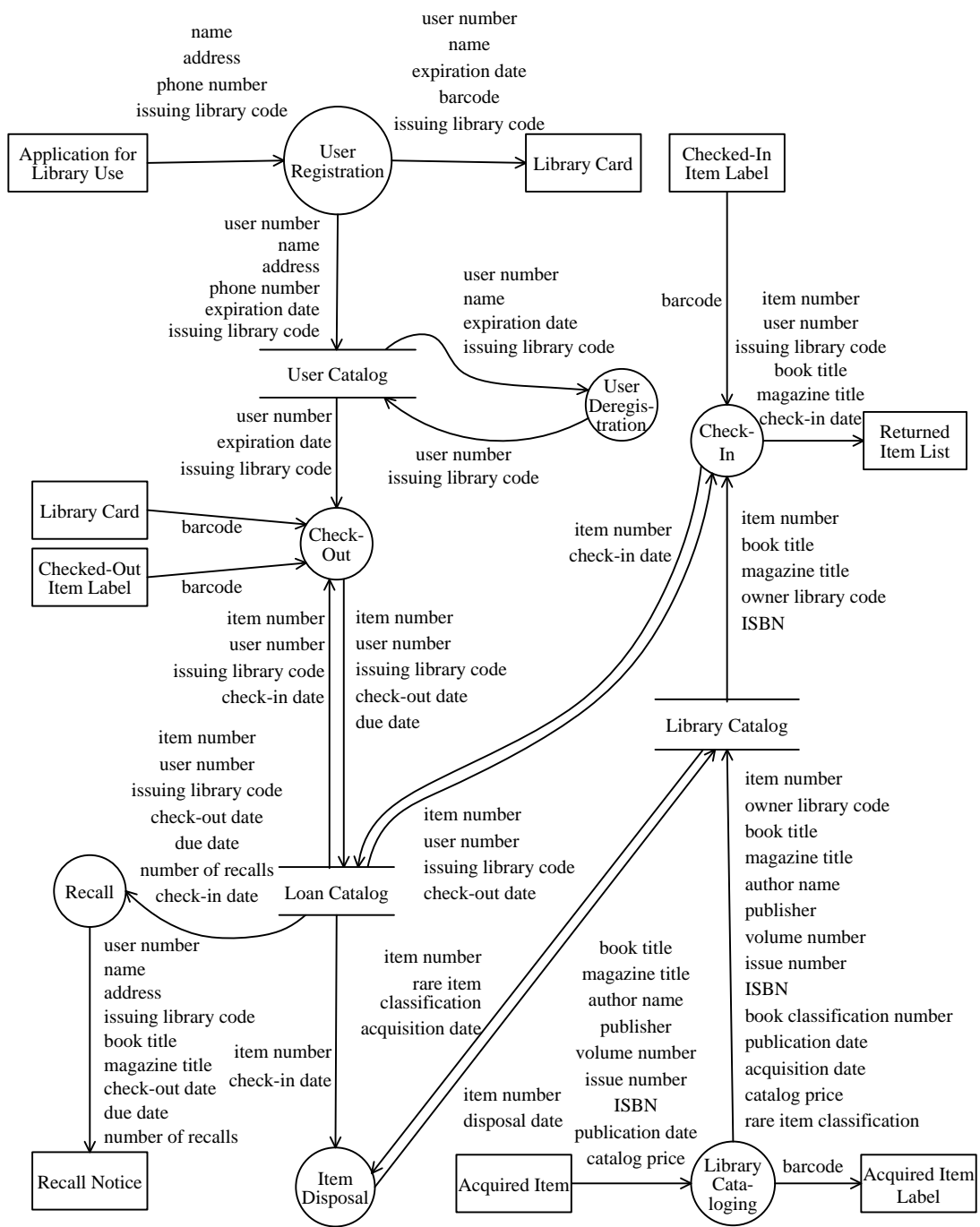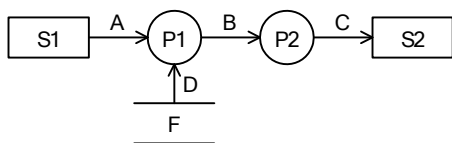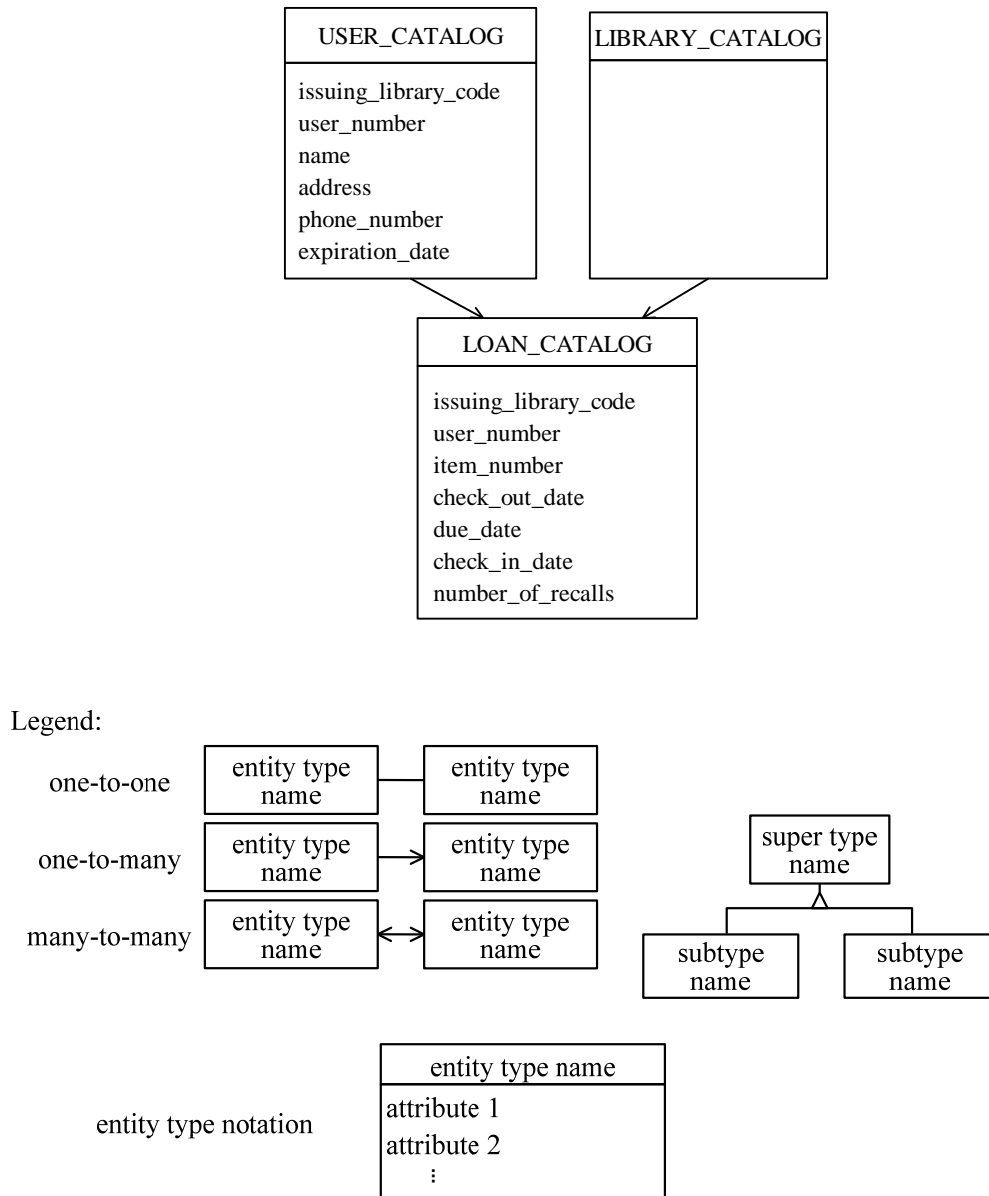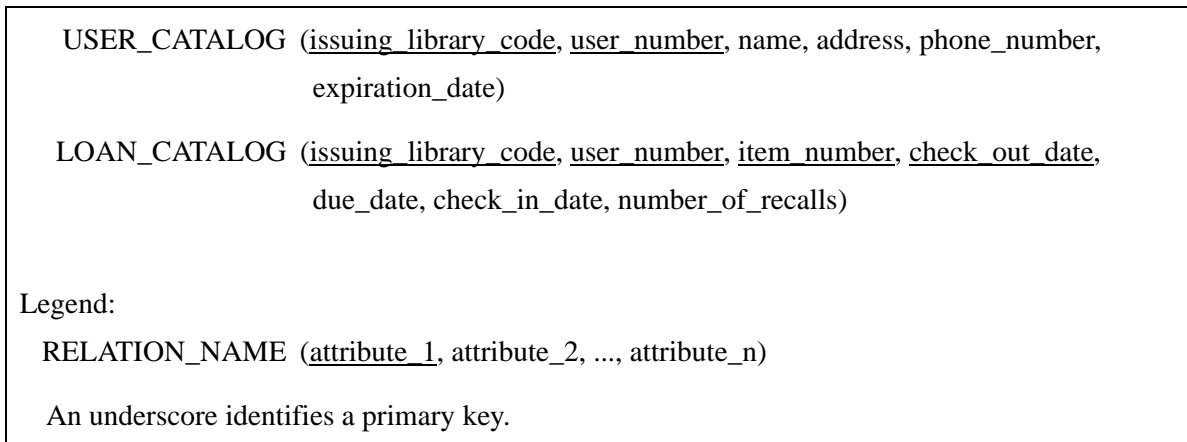
Fig. 2　DFD for Library Operations (partial, to be completed)

A conceptual data model for the library system was created (see Figure 3).   In this model, the entity types are library catalog, user catalog, and loan catalog.   None of the attributes of the library catalog, however, are given.

USER_CATALOG
issuing_library_code user_number name address phone_number expiration_date

LIBRARY_CATALOG

LOAN_CATALOG
issuing_library_code user_number item_number check_out_date due_date check_in_date number_of_recalls

Legend:

one-to-one

| entity type name | | entity type name |

one-to-many

| entity type name | → | entity type name |

many-to-many

| entity type name | ↔ | entity type name |

| super type name |

| subtype name | | subtype name |

entity type notation

entity type name
attribute 1 attribute 2 ⋮

Fig. 3   Conceptual Data Model for the Library System

Relational schemas, excluding that for the library catalog, were created on the basis of the conceptual data model shown in Figure 3 (see Figure 4).

```
USER_CATALOG (issuing_library_code, user_number, name, address, phone_number,
              expiration_date)

LOAN_CATALOG (issuing_library_code, user_number, item_number, check_out_date,
              due_date, check_in_date, number_of_recalls)


Legend:
  RELATION_NAME (attribute_1, attribute_2, ..., attribute_n)

  An underscore identifies a primary key.
```

Fig. 4　Relational Schemas for the Library System (partial)

Subquestion 1

Three data flows for the "Recall" process are missing in the DFD for Library Operations (Figure 2).　Give the starting point, ending point, and data of each missing data flow.

Subquestion 2

Create a conceptual data model for the entity type "LIBRARY_CATALOG" using three entity types: "ITEM," "MAGAZINE," and "BOOK," on the basis of the legend shown in Figure 3.　State all of the entity type names and attribute names.　Note that the entity type "ITEM" is a super type.

Subquestion 3

State the relational schemas for "ITEM," "MAGAZINE," and "BOOK" on the basis of the legend shown in Figure 4.

Subquestion 4

Create an SQL statement that finds the number of checked-out items of a given user in the "Check-Out" process.　It is assumed that the issuing library code on the user's library card is stored in the host variable ":library_code," and the user number in the host variable ":user_number."　The check-in date for checked-out items is assumed to be NULL.

Subquestion 5

Mr. B then decided that the collection management functions should be extended with a book search function.

[Book search function]

The book search function generates a list that includes the book title, author name, publisher, and ISBN for books (excluding those that are checked-out) in which a given keyword partially matches the book title, with no duplication.
Assuming that the SQL cursor that searches for the books is defined as "BookList,"

fill in blanks [A] through [C], [H] through [O] and

[R] in Figure 5 with the correct word or words, and fill in blanks [D]

through [G] and [P] and [Q] with X, Y, or Z.   The keyword is

assumed to be given in the host variable ":BookKeyword", and it is enclosed in leading and trailing wildcard characters for partial matches.   The search results are assumed to be stored in the cursor "BookList."

```
DECLARE BookList    [ A ]    FOR

  [ B ]    [ C ]    [ D ].book_title,  [ E ].author_name,

     [ F ].publisher,  [ G ].ISBN

  [ H ]   ITEM X, BOOK Y

  [ I ]    [ D ].book_title  [ J ]  :BookKeyword

AND Y.item_number = X.item_number

  [ K ]   [ L ]   [ M ]  (

     [ N ] *

        [ O ]   LOAN_CATALOG Z

   WHERE    [ P ].item_number = Z.item_number

      AND  [ Q ].check_in_date IS  [ R ] )
```

Fig. 5   Book Search Cursor Definition "BookList"

Subquestion 6

Mr. B further decided that the book title and ISBN should be added to the loan catalog to improve the efficiency of the process for creating a returned-item list of books. This means that two attributes will be added to an entity at the same time, which can cause data inconsistency in some situations. In this situation, however, there will likely be no problems with the maintenance of data integrity. Explain in 20 words or less why there will be no problems.

Subquestion 7

Mr. B lastly decided that the book reservation functions described below should be added to the library system.　He therefore prepared the DFD shown in Figure 6.

Complete the DFD by adding arrows that denote the data flow(s) and the data that must go to the "Book-Hold" process on the basis of the sample of DFD notation shown in Figure 2. Here, do not include data for specifying search keys.
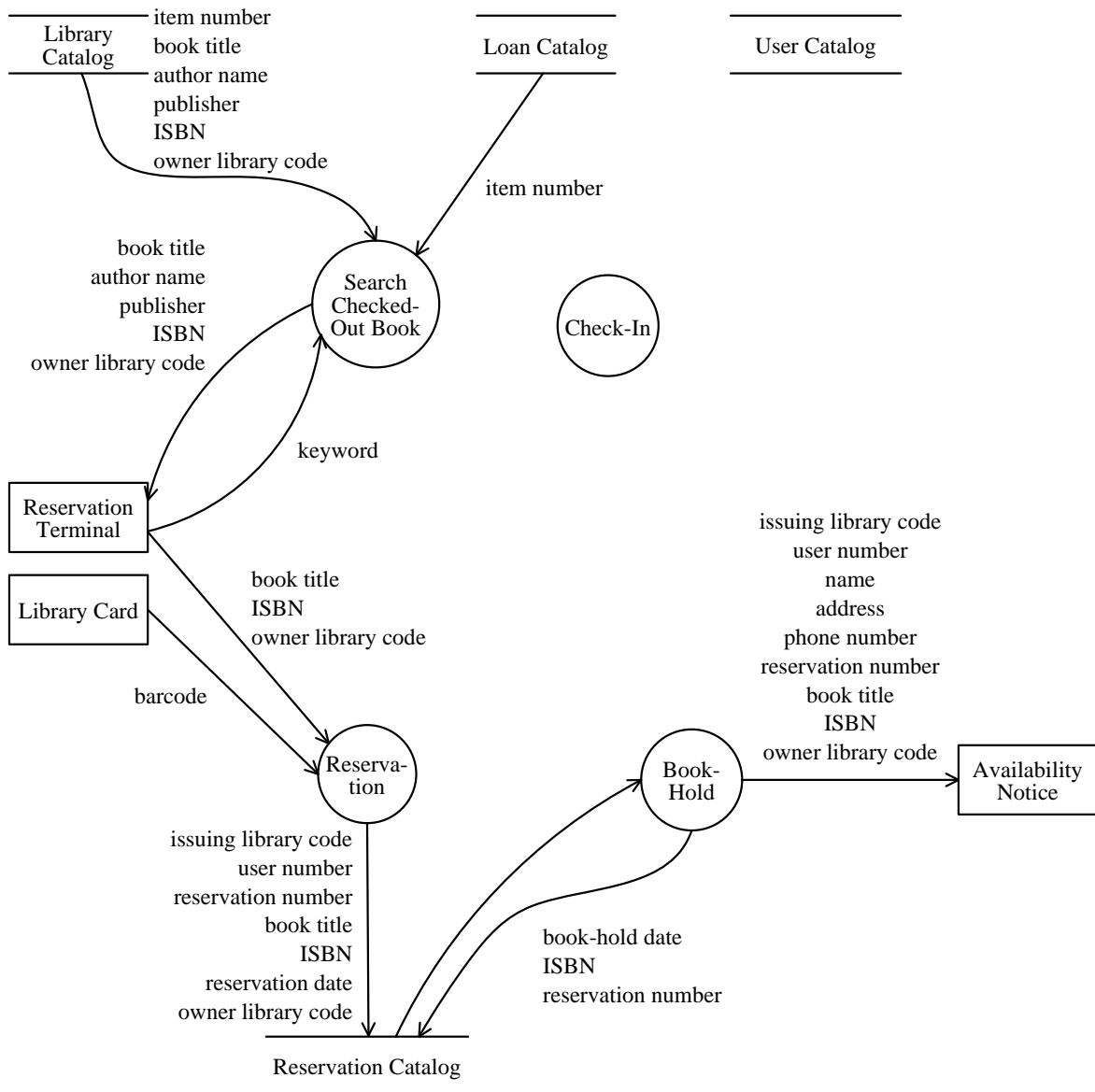
[Book reservation functions]

(Reservation)

From a reservation terminal, a user can reserve checked-out books.　When reserving a book, a user has the barcode on his/her library card scanned and then selects the desired book by using the "search checked-out book" function on the reservation terminal.　The reservation terminal screen shows the book's book title, ISBN, and owner library code. When the reservation process is completed, the reserved book is assigned a unique reservation number based on its ISBN.　The reservation number and the reservation date are logged in the reservation catalog.

(Book-hold)

If a book is registered as reserved in the reservation catalog, then the book-hold function is activated once the book is checked-in.　The book-hold function searches the reservation catalog for the reservation with the earliest reservation date logged for that book and assigns the book-hold date to the reservation.　Then, an availability notice is output.　A clerk then informs the user with the earliest reservation that the book is now available.

Fig. 6   DFD for the Book Reservation Function to Be Added
(partial, to be completed)