1 Databases (tgg22)

The following tables are part of a library's database system.

> Book(**book_id**, title, number_owned, number_borrowed)
> Person(**person_id**, name, address)
> Borrowed(**person_id, book_id**, number)

The primary keys of each table are in **bold**. In the table Book the column `number_owned` is the number of copies of the book owned by the library, while the column `number_borrowed` is the number of copies currently out on loan. In table Borrowed the column `person_id` is a foreign key into the Person table, the column `book_id` is a foreign key into the Book table. The column `number` is the number of copies of the book borrowed by the associated person. (This library is used by primary school teachers who frequently check out many copies of a book for the use in their classes.)

If the database is internally consistent, then the column `number_borrowed` is redundant information that can be computed from the actual number borrowed, and this can be derived from the Borrowed table.

(a) Write an SQL query that checks the internal consistency of this database. It should return records of the form

```
(book_id, number_borrowed, actual_number_borrowed)
```

only for those books where `number_borrowed` and `actual_number_borrowed` are not equal. That is, if the database is consistent the query will return no records.
[5 marks]

(b) Your job is to redesign this schema so that there is no need for such consistency checks. The first step is to design an Entity-Relationship model. You will do this by introducing a new entity called Copy_Of. Each copy of a book owned by the library will be associated with a unique member of the Copy_Of entity.

Design an Entity-Relationship diagram based on this idea and argue that cardinality constraints will ensure that the database is internally consistent.
[5 marks]

(c) Discuss at least two options for implementing your ER model in an SQL database.
[5 marks]

(d) Using one of your relational implementations from the previous part, write an SQL query that reproduces the contents of the Book table from the original design. That is, write an SQL query that returns records of the form

```
(book_id, title, number_owned, number_borrowed).
```

[5 marks]