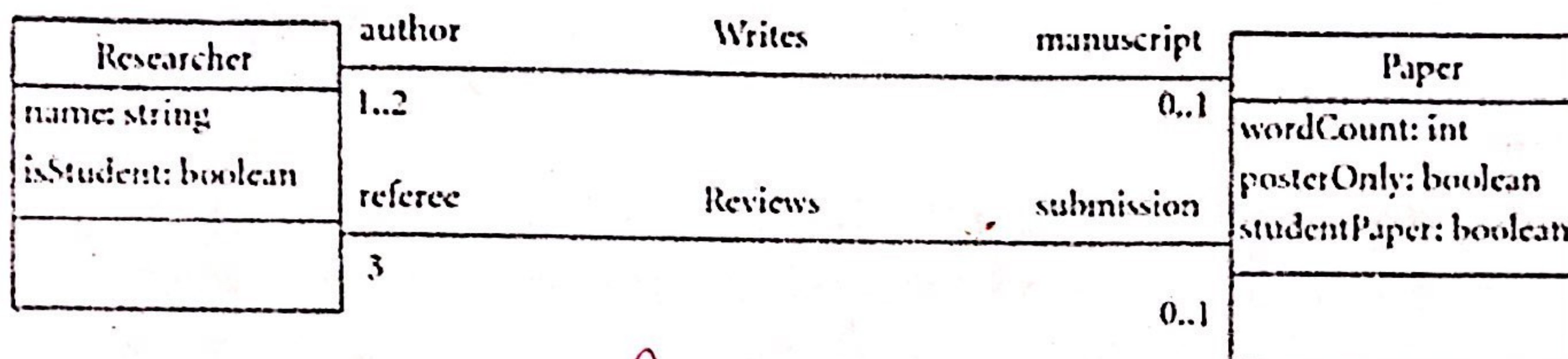| Course Name:	Formal Methods		Course Code:	SE2003
Degree Program:	BS SE		Semester:	Spring 2023
Exam Duration:	60 Minutes		Total Marks:	30
Paper Date:	8th April,2023		Weight	20
Section:	ALL		Page(s):	2
Exam Type:	Midterm-II		Instructor	Dr. Wafa Basit

Student : Name: _____ Roll No. _____ Section: 6A

Instruction/Notes:
- Make assumptions where necessary
- In case of multiple solutions, mention the final one
- Question # 1 and 2 have to be attempted on question paper.
- Please write neatly and to the point.

(handwritten marks: 25.5/30, 17.5/20)

Question # 1 (4 points each)

Write down the OCL specifications for the following problem. The following UML diagram shows relationships between Paper and Researcher classes. A researcher could be a student or a faculty member. Both of them can write a manuscript (research paper). But papers can be reviewed only by researchers that are faculty members (referees).

Researcher	author	Writes	manuscript	Paper
name: string	1..2		0..1	wordCount: int
isStudent: boolean				posterOnly: boolean
	referee	Reviews	submission	studentPaper: boolean
	3		0..1	

1. The researcher does not review his own manuscript.

   Context Researcher inv:
   Self.manuscript → not Empty() implies
   Self.manuscript → excludes (self.author)

   (handwritten note: Paper; mark 2.5)

2. The author of the StudentPaper is a student.

   Context Paper inv:
   self.studentPaper = true implies
   self.author.isStudent = true

   (mark 3)

3. There is no referee (reviewer) that is a student.

   Context Paper inv:
   self.referee → forAll includes(
   forAll (p: Researcher | p.isStudent = false)

   (mark 4)

4. wordCount of each paper will not be more then 4000.

   Context Paper inv:
   self.wordCount <= 4000

   (mark 4)

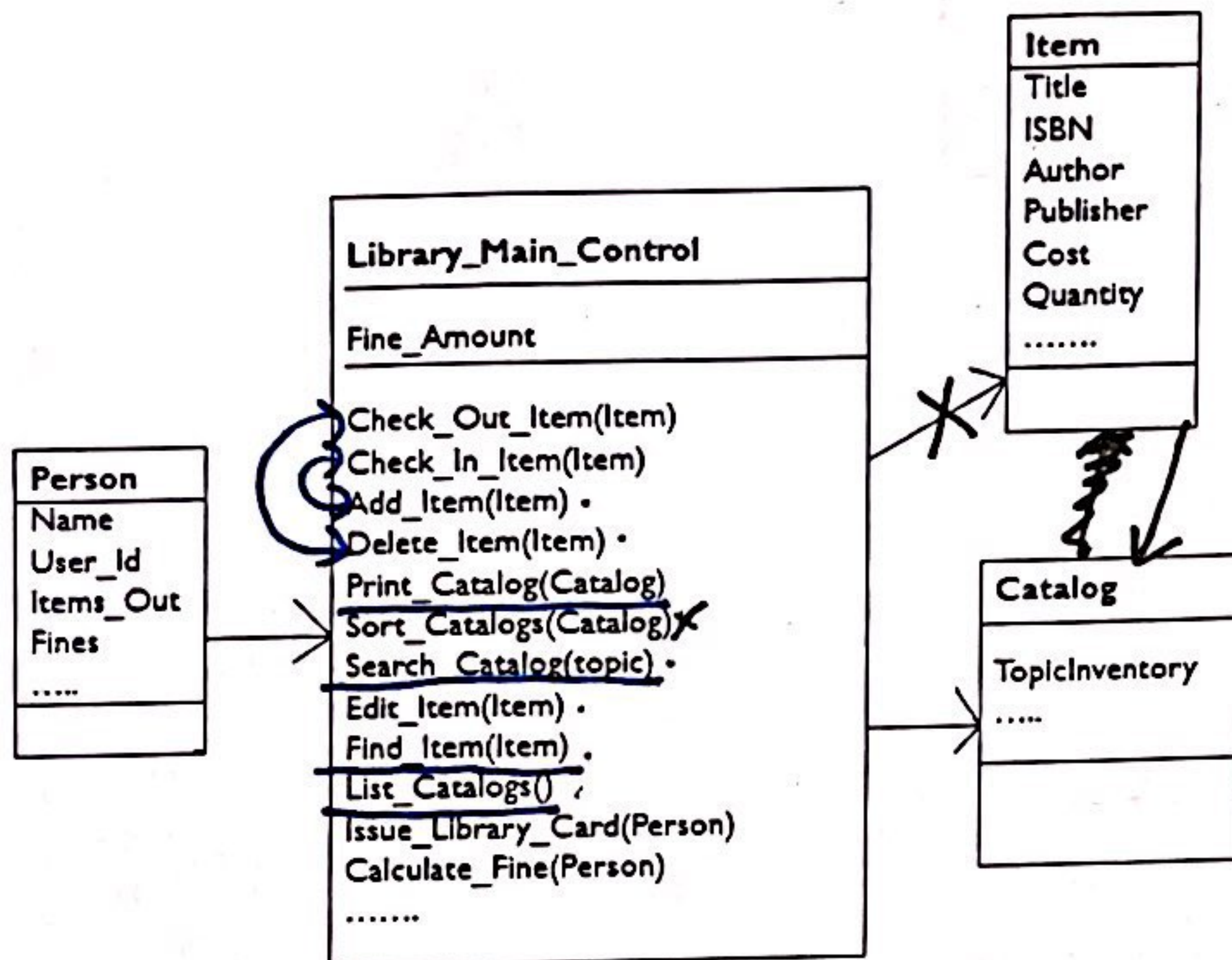Department of Computer Science   Page 1 of 2

5. A paper can have a maximum of two authors.

Context Paper ino:
self.author → size() <= 2

(4)

Question # 2: Analyze the following UML diagram.

```
                                    ┌──────────┐
                                    │ Item     │
                                    ├──────────┤
                                    │ Title    │
                                    │ ISBN     │
            ┌─────────────────────┐ │ Author   │
            │ Library_Main_Control│ │ Publisher│
            ├─────────────────────┤ │ Cost     │
            │ Fine_Amount         │ │ Quantity │
            ├─────────────────────┤ │ .......  │
            │ Check_Out_Item(Item)│ └──────────┘
            │ Check_In_Item(Item) │
┌────────┐  │ Add_Item(Item) •    │
│ Person │  │ Delete_Item(Item) • │
├────────┤  │ Print_Catalog(Catalog)
│ Name   │  │ Sort_Catalogs(Catalog)✗  ┌──────────┐
│ User_Id│  │ Search_Catalog(topic) •  │ Catalog  │
│Items_Out  │ Edit_Item(Item) •        ├──────────┤
│ Fines  │  │ Find_Item(Item) •        │TopicInventory
│ ....   │  │ List_Catalogs() ,        │ .....    │
└────────┘  │ Issue_Library_Card(Person)└──────────┘
            │ Calculate_Fine(Person)  │
            │ .......              │
            └─────────────────────┘
```

(8/10)

1. Identify bad smells in this design? (3 points) (1) Catalog should have items Not Library

→ Find_Item (Item) and Search Catalog (topic) • is Duplication (2)

→ List_Catalog and Print_Catalog is also duplication

→ Library_Main_Control is very Huge Class and doing to much coupling
→ Checkout and CheckIn Item are also duplication of add and delete ~~items~~
~~....~~ ~~........~~ ~~........~~ ~~and~~ ~~.......~~ ~~.........~~

2. Which refactorings would you apply to remove these bad smells, also identify the respective preconditions you will evaluate? (3 points)

~~Through the~~ Root ~~Cancel~~ Causal Refactoring	The class Library is big and many changes will be required
Method Extract	→ Library-Main-Control will have all list of catalogs
Class Extract	→ Items will be contained within the catalog

(3)

3. Only draw your final solution (on the back side of question paper? (4 points)

Department of Computer Science   Page 2 of 2

Scanned with CamScanner

Person (crossed out)

Person
- Name
- User ID
  .

Library_Main Control (crossed out)

Library_Main Control
- Print_Catalog (Catalog)
- Sort_Catalog (Catalog)
- Search_Catalog (Cat

Person

Person
- Name
- User_id
- Items_OUT
- Fines

Library_Main Control

Library_Main Control
- Fine_Amount
- CheckOUT_Item (Item)
- CheckIN_Item (Item)
- List Catalogs ()
- Search Catalog (topic)
- Sort Catalogs (Catalog)
- Issue_library_Card (Person)
- Calculate_Fine (Person)

// Here Search will print
// the catalog also. So duplication
removed.

③

Catalog

Catalog
- Topic Inventory
  .....
- Add Item (Item)
- Delete Item (Item)
- Edit Item (Item)
- Find Item (Item)

Item

Item
- Title
- ISBN
- Author
- Publisher
- Cost
- Quantity
  ....