Part 3: RA (12 points)

Write relational algebra expressions equivalent to Booktown queries 2, 3, 4 and 5 listed above. (2+3+3+4 points) (Notice that you do not need to represent the sorted order of the results of the queries in your relational algebra expressions. There may be a possibility for partial credit.)

Query2:

$\pi_{Subject}(\sigma_{Book\_ID = NULL}(Subjects \bowtie Subject\_ID = Books, Subject\_ID)))$

Query3:

$\rho(E, Editions) \wedge \rho(B, Books) \wedge \rho(A, Authors)$

$\pi_{ISBN}(\sigma_{B.Book\_ID = E.Book\_ID\ AND\ B.Author\_ID = A.Author\_ID\ AND\ A.First\_Name = 'Agatha'\ AND\ A.Last\_Name = 'Christie'} (E \times B \times A))$

Query4:

$\rho(A, Authors) \wedge \rho(B1, Books) \wedge \rho(B2, Books) \wedge \rho(S1, Subjects) \wedge \rho(S2, Subjects)$

$\pi_{A.First\_Name, A.Last\_Name}(\sigma_{A.Author\_ID\ in\ (\pi_{B1.Author\_ID}(\sigma_{S1.Subject = 'Children/YA'}(B1 \bowtie B1.Subject\_ID = S1.Subject\_ID)))\ x\ A.Author\_ID\ in\ (\pi_{A.Author\_ID}(\sigma_{S2.Subject = 'Fiction'}(B2 \bowtie B2.Subject\_ID = S2.Subject\_ID)))}$ A)

Query5:

$\rho(A, Authors) \wedge \rho(A1, Authors) \wedge \rho(B, Books)$

$\pi_{A.Author\_ID, A.First\_Name, A.Last\_Name}(\sigma_{NOT(\pi_{B.Subject\_ID}(\sigma_{A1.First\_Name = 'J.\ K.'\ AND\ A1.Last\_Name = 'Rowling'}(B \bowtie A1.Author\_ID = B.Author\_ID))}$

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$\pi_{B.Subject\_ID}(\sigma_{B.Author\_ID = A.Author\_ID}(B)))$ A)

Part 4: Normalization (20 points)

For this part, consider the following table and functional dependencies

F = {id → name, GPA, major, school;
    GPA → major;
    school → major;
    name, major → id }

1. List the candidate keys for this relation using ONLY the functional dependencies (4 points)
   - id
   - name, major

Superkeys →
   - id
   - name, major
   - name, GPA
   - name, school

2. Is the relation 3NF? Justify your answer (6 points)
   - Yes. For the first relation id is a super key. Similarly for the fourth relation, name,major is a super key. For the second and third relations, 'major' is part of the name, major candidate key. Thus the relation is 3NF.
   -
3. Is the relation BCNF? Justify your answer (6 points)
   - No. The second and third relations (GPA → major and school → major) violate BCNF as GPA and School are not super keys.

4. Which of the functional dependencies are violated in the snapshot of the table provided? (4 points)
   - GPA to major (english and astronomy)
   - School to major (engineering and cs)