



THE UNIVERSITY
of LIVERPOOL

JANUARY 2002 EXAMINATIONS

Bachelor of Arts : Year 3
Bachelor of Science : Year 3

TOPICS IN DATABASES

TIME ALLOWED : Two Hours and a Half

INSTRUCTIONS TO CANDIDATES

Answer *all* questions in Section A
Answer *two* question from Section B

If you attempt to answer more than the required number of questions (in any section), the marks awarded for the excess questions will be discarded (starting with your lowest mark).



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SECTION A

Answer **ALL** Questions in this section.

1. Web-like or semistructured databases.

- (a) What are semistructured or Web-like databases and why do we need them? **6 marks**
- (b) Define what is meant by a query to a set-theoretical database. In what ways is this different from a query to a standard relational database? **6 marks**
- (c) Suppose the notes for a lecture course are presented as a Web page organised as a lengthy list of contents consisting of hyperlinks to all the course note Sections and SubSections. Describe the *four* stages that a Web query system might use to generate a single (printable) version of these course notes. What is the main way in which such a Web query systems differs from a standard Web search engine? **10 marks**
- (d) What is an XML representation of bracket expressions with labels and atomic values (urelements)? **4 marks**
- (e) By using, for example, the operation $x_1, x_2 \mapsto \{x_1, x_2\}$, explain how can set-theoretic operations be computed in terms of graphs. **8 marks**
- (f) Show how the information: "Alan is aged 42. His e-mail address is agb@abc.com", may be represented using (i) attributes or (ii) elements of XML. **5 marks**
- (g) In which two ways is XML used to represent trees? **3 marks**

2. Deductive Databases (Datalog)

- (a) In terms of dependency graph, what is the difference between recursive and non-recursive datalog? What is the advantage of recursion? Give an example of a recursive datalog definition. **5 marks**
- (b) What are range restricted rules in datalog? Which of the following rules are not range restricted? Why do we need this restriction?

$p(X, Y) :- X = Y, \text{ not } Z = a, q(X).$
 $p(X, Y) :- X = Z, X = a, \text{ not } q(Z).$
 $p(X, Y) :- X = Z, q(X), Z = Y.$

8 marks

- (c) Translate into **nr-datalog**⁷ the following relational algebra expression over p, q, r . The arity of p is 3. Find the arities of q, r which make this expression correct:

$$(r \setminus \pi_{2,2}(p)) \cup (q \times \{\langle a \rangle, \langle b \rangle\}).$$

9 marks

3. Multidatabase Systems: Briefly, describe what is meant by *Global Schema Integration* in multidatabase systems. State *three* advantages and *three* disadvantages of this approach.

6 marks



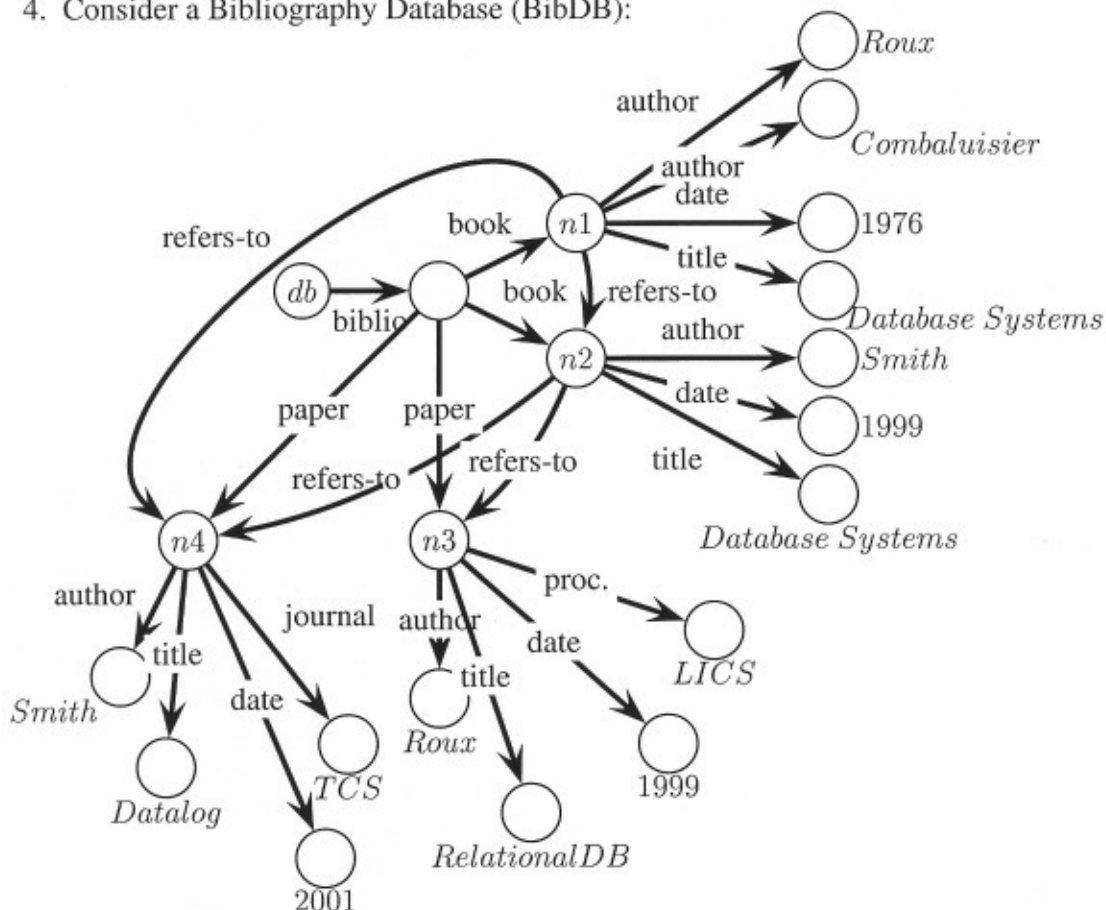
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SECTION B

Answer only **TWO** Questions from this section.

Credit will be given for the best two answers in Section B.

4. Consider a Bibliography Database (BibDB):



Express in English the following query from the *core query language* and draw the corresponding answer graph.

```
select L: {authors: (select author: A
                    from N.author A),
          title: T}
from biblio.L N,
     N.title T,
     N.refers-to M
where
     M.refers-to is empty
```

15 marks

5. Define the syntax of the basic language Δ and explain its set-theoretic semantics and which role this language plays. **15 marks**



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6. Explain what descriptive complexity theory is and how it can be used in the characterisation of the expressive power of query languages, and in particular of some extensions of the language Δ of the previous question.

15 marks

7. Consider a bibliography database in `www.a.b./bib.xml` of the form

```
<bib>
  <authorandpublications>
    <authors>
      L. Tolstoy
    </authors>
    <book>
      War and Peace
    </book>
    <book>
      Anna Karenina
    </book>
  </authorandpublications>
  <authorandpublications>
    <authors>
      Abiteboul, Buneman, Suciu
    </authors>
    <book>
      Semistructured Databases
    </book>
  </authorandpublications>
</bib>
```

What is the informal meaning and the precise result of the following query in XML-QL:

```
<newbib>
where <authorandpublications> <authors> $A </> <book> $B </> </>
  in "www.a.b./bib.xml"
construct <book>
  <authors> $A </>
  <title> $B </>
</>
</newbib>
```

15 marks

END OF PAPER