XML Database Mastery Exam

Database Systems Department

April 29, 2025

Instructions

- This exam covers all fundamental and advanced concepts of XML databases
- Duration: 180 minutes
- Answer all questions
- For coding questions, write syntactically correct XML, XQuery, or XPath as appropriate

1 Conceptual Questions (20 points)

1. (4 points) Compare and contrast XML databases with traditional relational databases, listing at least three key differences.
2. (3 points) Explain the concept of *document-centric* vs *data-centric* XML with examples of each.
3. (4 points) Describe the XML Data Model with its main components. How does it differ from the relational model?
4. (3 points) What is XML Schema (XSD) and how does it improve upon DTDs?
5. (3 points) Explain the significance of namespaces in XML databases with an example.

6. (3 points) What are the advantages of using a native XML database over XML support in relational databases?

2 XML Fundamentals (20 points)

1. (5 points) Given the following XML document, identify and correct all syntax errors:

```
<library>
    <book id="101">
        <title>XML Mastery<title>
        <author>John Doe
        <year>2023</year>
    </book>
    <book id="102">
        <title>Advanced XQuery</title>
        <author>Jane Smith</author>
        <year edition="second">2022</year>
    </book>
</library
```

2. (5 points) Design an XML Schema (XSD) for the corrected library XML document above.

3. (5 points) Create a DTD that validates the following structure:

   - A `<university>` contains one or more `<department>` elements
   - Each `<department>` has exactly one `<name>` and one or more `<course>` elements
   - Each `<course>` has attributes `code` (required) and `credits` (optional)

4. (5 points) Transform this XML data into a well-formed HTML table using XSLT:

```
<products>
    <product>
```

```
            <id>P1001</id>
            <name>Laptop</name>
            <price>899.99</price>
        </product>
        <product>
            <id>P1002</id>
            <name>Mouse</name>
            <price>24.99</price>
        </product>
    </products>
```

3 XPath and XQuery (30 points)

Given the following XML document for questions 1-5:

```
<bookstore>
    <book category="cooking">
        <title lang="en">Everyday Italian</title>
        <author>Giada De Laurentiis</author>
        <year>2005</year>
        <price>30.00</price>
    </book>
    <book category="children">
        <title lang="en">Harry Potter</title>
        <author>J.K. Rowling</author>
        <year>2005</year>
        <price>29.99</price>
    </book>
    <book category="web">
        <title lang="en">XQuery Kick Start</title>
        <author>James McGovern</author>
        <author>Per Bothner</author>
        <year>2003</year>
        <price>49.99</price>
    </book>
    <book category="web">
        <title lang="en">Learning XML</title>
        <author>Erik T. Ray</author>
```

```
        <year>2003</year>
        <price>39.95</price>
    </book>
</bookstore>
```

1. (5 points) Write XPath expressions to:
   - Select all book titles
   - Select prices of books published after 2003
   - Select books with exactly one author
   - Select titles of books in the "web" category
2. (5 points) Write an XQuery to list all books with price greater than $35, displaying title, author(s), and price sorted by price descending.
3. (5 points) Write an XQuery FLWOR expression that groups books by year and counts how many books were published each year.
4. (5 points) Write an XQuery function that accepts a category parameter and returns the average price of books in that category.
5. (5 points) Write an XQuery update expression to:
   - Increase all prices by 10%
     item Add a new book to the bookstore
   - Delete all books published before 2004
6. (5 points) Explain the difference between XQuery 1.0 and XQuery 3.1 with at least three significant improvements in 3.1.

4 Advanced XML Database Concepts (30 points)

1. (6 points) Compare the following XML database approaches:
   - Native XML databases (e.g., eXist-db, BaseX)
   - XML-enabled databases (e.g., Oracle XML DB, SQL Server XML features)
   - XML as BLOB in relational databases

2. (5 points) Explain XML indexing strategies in native XML databases. What types of indexes are typically used and why?

3. (5 points) Describe the challenges of transaction management in XML databases and how they differ from relational databases.

4. (6 points) Discuss XML database performance optimization techniques including:

   - Schema design considerations
   - Query optimization
   - Appropriate use of XML features vs relational features in hybrid systems

5. (4 points) What are the security considerations specific to XML databases? Discuss XML encryption and XML signature.

6. (4 points) Explain how full-text search works in XML databases and compare it with traditional relational full-text search.

5 Practical Application (20 points)

1. (10 points) Design an XML database schema for a hospital management system that needs to track:

   - Patients (with medical history as hierarchical data)
   - Doctors (with specialties and schedules)
   - Appointments
   - Prescriptions (which may contain complex structured data)

   Provide both the XML Schema (XSD) and sample XML documents.

2. (10 points) A company needs to integrate product data from multiple suppliers who each provide XML in different formats. Design an XQuery solution that:

   - Transforms different supplier formats into a common format
   - Merges the data

- Identifies and handles inconsistencies
- Produces a unified inventory report

Provide the XQuery code and explain your approach.

Bonus Question (10 points)

Design a complete RESTful API specification for interacting with an XML database that:

- Supports CRUD operations on XML documents
- Allows XQuery execution
- Supports versioning of documents
- Includes authentication and authorization

Specify the endpoints, HTTP methods, request/response formats, and status codes.