Birkbeck  
(University of London)  

MSc Examination  

Department of Computer Science and Information Systems  

Internet and Web Technologies (COIY063H7)  
15 Credits  

Date of Examination: 6 June 2018  
Duration of Paper: 10:00 – 12:00  

There are seven questions on this paper.  
Answer only five of the seven questions.  
If you answer more than five questions, only the best five answers will count.  
Each question carries 20 marks in total.  
The paper is not prior-disclosed.  
The use of electronic calculators is not permitted.
1. Consider the following XML representation for film screenings at a cinema:

```xml
<cinema>
  <film>
    <title>...</title>
    <schedule>
      <day>Mon</day> ... <day>Fri</day>
      <time>15:00</time><time>18:00</time>
    </schedule>
    <schedule>
      <day>Sat</day><day>Sun</day>
      <time>12:00</time> ... <time>18:00</time>
    </schedule>
  </film>
  ...
</film>
</cinema>
```

In other words, a cinema has a number of films showing, with each film having one or more schedules which give days and times of screenings. For a particular film, there may be one set of times for Monday to Friday, say, and another set for Saturday and Sunday. Each day is included at most once among all the schedules for a particular film.

(a) Write one or more XSLT template rules (do not worry about including the `stylesheet` element) to transform an XML document conforming to the above description into an HTML document described as follows. The HTML document lists the titles of films showing on Saturday (“Sat”) and their times. There is an `h1` heading with the value “Films on Saturday”. This is followed by a table, with each row containing a film title and a time at which the corresponding film is shown on Saturday (so there might be multiple rows containing the same film title).

(14 marks)

(b) Assume that you were asked to provide a Document Type Definition (DTD) which would be used to validate XML documents representing cinema listings described as above. Describe three desirable constraints on the contents of a document that you would not be able to capture in the DTD and explain why they could not be captured.

(6 marks)
2. (a) Consider the following network comprising 6 nodes and 9 links:

![Network Diagram]

The nodes are labelled A to F, while each link is labelled with its cost. Recall the open shortest path first (OSPF) routing algorithm which computes costs from a single source node to all other nodes. Assume that the source node is A.

i. What is the cost of the shortest path from node A to node F, as computed by OSPF?  
(1 mark)

ii. List all the shortest paths between A and F?  
(2 marks)

iii. In the algorithm, the cost from A to D is initially found to be 4, but this is subsequently revised to a smaller value. Explain precisely, with reference to how the algorithm works, why this is the case.  
(3 marks)

(b) One of the fields in the header of an IP (Internet Protocol) datagram represents time-to-live. Explain what this field contains and how the field is used by IP.  
(6 marks)

(c) TCP (Transmission Control Protocol) uses sequence numbers and acknowledgement numbers. Describe what values these two numbers take, what these numbers represent and how they are used in the protocol. Also explain what is meant by stating that TCP uses cumulative acknowledgements.  
(8 marks)
3. (a) Consider the following two incomplete rules which might be part of a stylesheet written using CSS (Cascading Style Sheets):

```
a, b { ... }
c d { ... }
```

What are the names given to the two different kinds of selector used above, and how do they differ in meaning? (6 marks)

(b) In the JSONiq query language for JSON (as well as in XQuery), the `let` and `for` constructs might appear similar but in fact operate rather differently. Explain their differences by comparing the output of the following query which uses `let`:

```
let $i := 1 to 5
return {"number": $i}
```

to that of the following query which uses `for`:

```
for $i in 1 to 5
return {"number": $i}
```

(6 marks)

(c) Explain the purpose of the Address Resolution Protocol (ARP) and describe briefly how it works. (8 marks)
4. (a) Consider the following DTD fragment:

```
<!ELEMENT books (book)+
<!ELEMENT book (author*, title, isbn?, price)>
<!ELEMENT author (first-name?, last-name)>
```

Now write down absolute XPath expressions for the following queries on a document valid with respect to the above DTD fragment and with books as its root element:

i. Find each book which has more than 2 authors. (4 marks)

ii. Find each author of each book such that the author has a first-name and the book has an isbn. (4 marks)

(b) Describe the fundamental differences between TCP (Transmission Control Protocol) and UDP (User Datagram Protocol). State why UDP might be used in preference to TCP, and name one application layer protocol that uses UDP. (8 marks)

(c) What is the main purpose of the event attributes in HTML? Name three different types of event and explain when they are triggered. (4 marks)

5. (a) Consider using an XML document to represent a person’s wine collection. The collection consists of one or more wines. Each wine is of type “white” or “red” and this information must be provided for each wine. Each wine has a name, a price and an optional vintage (i.e., year). A wine also comprises zero or more grape varieties (e.g., Chardonnay), each with an optional percentage associated with it (having zero grape varieties is interpreted as not knowing what grapes the wine is made from). The price is either per bottle or per case, with the default being per bottle.

Write down a Document Type Definition (DTD) which satisfies the requirements described above. (14 marks)

(b) HTTP (Hypertext Transfer Protocol) uses headers in its messages. What format is used for each header? Describe the function of two request headers and three response headers used by HTTP. (The request headers and response headers you describe should be different from one another.) (6 marks)
6. (a) Explain the problem that XML namespaces are designed to solve. Describe the syntax used to declare an XML namespace.  

(4 marks)

(b) The Document Object Model (DOM) provides a number of methods for navigating and manipulating the in-memory representation of a document. Describe the functionality provided by four of these methods, stating the object to which each method applies.  

(4 marks)

(c) What is the Dynamic Host Configuration Protocol (DHCP) used for? Describe the four steps used in a DHCP client-server interaction.  

(6 marks)

(d) In order to handle transmission errors, data is often represented in terms of codewords. Explain what is meant by the term codeword. In this context, what is meant by Hamming distance? Explain the significance of Hamming distance with respect to the problem of transmission errors.  

(6 marks)

7. (a) Explain what is meant by the maximum transmission unit (MTU) for a network. What problems does this cause on the Internet, and how does IP (Internet Protocol) handle these problems?  

(10 marks)

(b) The HTML form element can have action and method attributes. Explain what types of values are expected for each of these attributes, as well as the functionality provided as a result of using these attributes.  

(4 marks)

(c) Base64 encoding is used when transferring 8-bit binary data in email messages. Explain briefly how Base64 encoding and decoding is performed. (You do not need to worry about the actual encoding used for particular bit sequences.)  

(6 marks)