This paper comprises seven 20-mark questions. Candidates must answer exactly FIVE questions. Calculators are not permitted. The paper is not prior-disclosed.
1. (a) Consider the following JavaScript code which uses the jQuery library:

```javascript
function getXML(myUrl) {
    var xhr = $.ajax({
        url: myUrl,
        datatype: "xml",
        async: false
    });
    return xhr.responseXML;
}
```

Explain precisely, line by line, what the code from lines 2 to 7 does. (7 marks)

(b) In TCP/IP, the network layer provides a mechanism which allows one machine to communicate with another over the Internet. Explain what additional functionality the transport layer provides. Now explain the main differences between the TCP and UDP transport layer protocols. (13 marks)

2. (a) Consider the use of XML to represent information about the results of a particular tennis tournament. The application is described as follows. A tournament is a sequence of matches. Each match is between two players. For each player, the result of the match is either “won” or “lost”. For each player, the number of games they won in each of between 2 and 5 sets (inclusive), is recorded. Write down a suitable Document Type Definition (DTD) for this application. (10 marks)

(b) Common Gateway Interface (CGI) was the first mechanism introduced to allow web servers to run scripts in order to generate dynamic content. Explain at a high level what CGI provides as well as its disadvantages. (5 marks)

(c) 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. (5 marks)
3. Consider the following (simplified) DTD (Document Type Definition) for representing information about online auctions, where open.auctions is the document (root) element:

```
<!ELEMENT open_auctions (open_auction*)>
<!ELEMENT open_auction (initial, reserve?, bidder*, seller)>
<!ELEMENT bidder (name, bid)>
<!ELEMENT seller (name)>
<!ELEMENT name (#PCDATA)>
```

(a) Assume that the above DTD is stored in a file named auction.dtd in the same directory as an XML document recording information about an online auction. How would the XML document refer to the DTD file? (You do not need to remember the precise syntax, but do need to name the construct used for this, state where it must appear in the XML document, and describe what information it provides.)

(5 marks)

(b) Now compose a set of XSLT template rules (do not worry about the stylesheet element itself) that, when given an XML document conforming to the DTD described above, will output an HTML table, such as that shown below. The table below would be generated for a document in which there are two open auctions. For the first auction, the seller is a person named Jack and the initial price is 20; for the second auction, the seller is a person named Jill and the initial price is 10. For the first auction, there are two bidders: Lucy makes bid 30, while Bill makes bid 40. The bid of 30 is less than the reserve price (not shown in the table), while the bid of 40 meets or exceeds it. There are no bidders for the second auction.

<table>
<thead>
<tr>
<th>Seller</th>
<th>Initial price</th>
<th>Bidder</th>
<th>Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jack</td>
<td>20</td>
<td>Lucy</td>
<td>30 (&lt;)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bill</td>
<td>40</td>
</tr>
<tr>
<td>Jill</td>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In other words, the table contains a header row and one row for each open auction, containing the name of the seller and the initial price. Following the row for each auction, the table contains rows for each bidder in that auction, with the name of the bidder and the bid, followed by (<) if the reserve price has not been met.

(15 marks)
4. (a) Consider an XML document representing information about winners of the Booker prize. The root element is `booker` which has one or more `award` child elements. Each `award` element has an `author`, a `title` and a `year` element as children. Assuming no initial context has been set, express the following two queries in XPath:
   i. Find the number of times the author “J.M. Coetzee” has won the award.

   (8 marks)

(b) Explain the advantage of *persistent connections* in the context of HTTP (the Hypertext Transfer Protocol).

   (4 marks)

(c) Consider the following entry in a Network Address Translation (NAT) table:

<table>
<thead>
<tr>
<th>WAN side</th>
<th>LAN side</th>
</tr>
</thead>
<tbody>
<tr>
<td>138.76.29.7, 5001</td>
<td>10.0.0.1, 3445</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

Explain how this entry would be used by a NAT-enabled router. Now give two criticisms which have been made regarding the use of NAT.

   (8 marks)

5. (a) Explain the *caching* mechanism used by Domain Name System (DNS) servers. You should explain its purpose, the kinds of answers which can be returned, and what happens when nothing is initially cached.

   (10 marks)

(b) In both URIs and XML, certain characters each have a special meaning. Explain the mechanism used for escaping the special meaning of these characters in the syntax for URIs and the syntax for XML.

   (6 marks)

(c) Sketch the Manchester encoding on a classic Ethernet for the bit stream 1100. Make sure that you include the time slots in your diagram.

   (4 marks)
6. (a) For an XML document, we can state that it is well-formed and/or that it is valid. Explain the difference in meaning between these two terms. (3 marks)

(b) Explain the need for namespaces in XML. (4 marks)

(c) Write the JavaScript code necessary to delete from the document currently displayed by the browser the element whose id attribute value is target. (7 marks)

(d) Consider four computers A, B, C and D connected to an Ethernet network. Assume that B starts to transmit on the network at time $t_0$. At a short time later, at time $t_1$, D starts to transmit, which results in a collision with B’s transmission. Draw a diagram showing the propagation of the signals from B and D through the network. Your diagram should indicate the points at which each of B and D detect the collision, as well as the points at which they each abort their transmissions. (6 marks)

7. (a) JSON provides an alternative syntax for representing data on the web. What does the acronym JSON stand for? List the data types provided by JSON (you need not explain the syntax of each). (7 marks)

(b) Consider the following two incomplete rules which might be part of a stylesheet written using CSS:

```
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)

(c) When using IPv4 addresses, the Classless Inter-Domain Routing (CIDR) notation represents addresses in a form such as 192.52.40.0/22, as an example. Explain what this notation is used to denote. Now consider a router which has the following two entries in its forwarding table:

```
<table>
<thead>
<tr>
<th>Address</th>
<th>Next hop</th>
</tr>
</thead>
<tbody>
<tr>
<td>192.52.40.0/22</td>
<td>Router 1</td>
</tr>
<tr>
<td>default</td>
<td>Router 2</td>
</tr>
</tbody>
</table>
```

For each of the IP addresses (i) 192.52.43.5 and (ii) 192.52.48.5, which next hop does the router choose when it receives a packet with that address? Explain your answers. (7 marks)