There are seven questions on this paper.
Answer only five of the five 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. (a) Consider an application where information about a person’s library of music recordings is represented in an XML file with the following constraints. A library element contains any number of album or track elements. An album has a title element along with one or more track elements. Each track element has a title element and an artist element, followed by optional time and genre elements. Write down the necessary Document Type Definition (DTD) element declarations which satisfy these requirements.

   (10 marks)

(b) Given an XML document satisfying the requirements of the DTD in Question 1(a), write down XPath expressions to select each of the following (assuming no initial context):

   i. The titles of those tracks which have both a time and a genre specified.

   (5 marks)

   ii. The albums with more than 10 tracks.

   (5 marks)

2. (a) Given a namespace declaration on a particular element in an XML document, describe the scope of that declaration. Can an element within the scope of the declaration belong to a different namespace? Explain your answer.

   (5 marks)

(b) Describe (using an example) how single-bit errors can be corrected using RAC (row and column) parity. Can all two-bit errors be corrected? Explain your answer.

   (8 marks)

(c) When TCP establishes a connection, what two pieces of information are exchanged between the client and server processes?

   (3 marks)

(d) Assume that the ASCII characters soh and eot are used to delimit a frame of data. The following fragment of data occurs in the middle of a data stream which is to be transmitted using byte stuffing: A B esc C esc eot soh D. What is the output after stuffing?

   (4 marks)
3. (a) Consider the following source code for an HTML page:

```html
<html>
<body>
<p>
<?php
   if ($_GET['inventor'] == "Berners-Lee")
      echo "Congratulations."
   else
      echo "Sorry, please try again."
?>
</p>
</body>
</html>
```

Assume that the URL of the page is http://www.dcs.bbk.ac.uk/server/test.html.

i. Explain step-by-step how the if statement above would be evaluated, along with any outcome.

(5 marks)

ii. Write down the URL which would cause the line containing “Congratulations” in the page to be executed.

(2 marks)

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

(6 marks)

(c) Consider the following network comprising 5 nodes and 7 links:

```
A -- 1 -- B -- 3 -- D
  |            |
  | 1          | 2
  v
C -- 1 -- E
```

The nodes are labelled A to E, 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. Assuming the source node is A, what costs would be computed by OSPF for each of the nodes B, C, D and E? Show how you arrived at your answers, including any costs modified during the process.

(7 marks)
4. (a) Consider the following JavaScript code:

```javascript
window.onload = function() {
    document.getElementById("hello-button").onclick = hello;
}
```

For each of the components of the above code (window, onload, document, getElementById, hello-button, onclick and hello), explain what the component represents or what it does.

(7 marks)

(b) Consider the following sequence of Transmission Control Protocol (TCP) segment exchanges between two hosts:

Host A sends segments with sequence numbers 122 and 130 at times $t_1$ and $t_2$, respectively, to Host B. The first acknowledgement Host B sends to Host A is lost.

(i) What acknowledgement numbers does Host B send back to Host A in each case (labelled with “?” in the diagram)?

Now consider the timeout interval at Host A for the segment with sequence number 122. (ii) Explain why Host A does not retransmit if the interval expires after $t_3$.

Explain how the above interaction would have been different if the timeout interval had expired (iii) before $t_2$, and (iv) after $t_2$ but before $t_3$.

(7 marks)

(c) One of the IPv4 address spaces used for private internets is identified by the network prefix 192.168/16. Explain what this notation means. How many IP addresses could be allocated to individual machines within this address space? Justify your answer.

(6 marks)
5. (a) The servers comprising the Domain Name System (DNS) are organised in a distributed manner. Explain the advantages of this distributed organisation over a centralised one. What is the name given to the software which translates a DNS name into an IP address?

(5 marks)

(b) Consider data about publications represented in XML format. The document element is `publications`, which contains many `article` elements as children. Each `article` has one or more `author` elements as well as a `title` element as children. Write down a set of XSLT template rules (do not worry about the stylesheet element itself) which will transform an XML document as described above into an HTML document as follows. There is an `h1` heading with the contents “List of publications”. This is followed by an unordered list in which each list item corresponds to an article, formatted as follows. The author names appear first, each followed by a comma. The last author name should be preceded by “and”, unless the author is the only author of the article. The title of the article follows the author names, is enclosed in double-quotes, and is followed by a full-stop. So, for example, an article with the following content model

```xml
<author>Jones</author><author>Smith</author><title>XSLT</title>
```

would be output as: Jones, and Smith, “XSLT”.

(15 marks)
6. (a) 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)

(b) Explain the difference between the following two selectors used in a Cascading Style Sheet (CSS) specification.

```css
.red { color: red; }
#red { color: red; }
```

(4 marks)

(c) The general format of an HTTP client request message is as follows:

```
method URL-path HTTP-version
headers
<blank line>
message-body
```

i. Name and describe the function of two HTTP methods.

(4 marks)

ii. Describe the purpose of two headers which can appear in a client request message.

(4 marks)

iii. Under what circumstances can the message body be empty?

(2 marks)
7. (a) How many bits are used for each IPv6 address? Explain the differences in the way IPv6 addresses are written down compared to IPv4 addresses.

(4 marks)

(b) Certain elements in HTML are not required to have start and/or end tags, whereas all elements in XHTML must have both start and end tags. Explain why this is the case. How does an HTML parser manage to deal with missing start and/or end tags in a document?

(6 marks)

(c) Consider an adaptive or learning bridge connecting two LAN segments, segment 1 and segment 2. Computers A, B and C are on segment 1, while computers D and E are on segment 2. Fill in the blank entries in the table below. In particular, for each event (given in the first column), give the hosts that the bridge knows to be in Segment 1 (second column) and in Segment 2 (third column); give also (in the fourth column) the segments on which the frame is sent for each event. When the bridge first boots, it has no information about the locations of the computers.

<table>
<thead>
<tr>
<th>Event</th>
<th>Segment 1</th>
<th>Segment 2</th>
<th>Frame sent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridge boots</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>A sends to E</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>D broadcasts</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>E sends to D</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>B sends to C</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>A sends to B</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

(10 marks)