This paper comprises seven 20-mark questions. Candidates must answer exactly FIVE questions. Calculators are not permitted.
1. (a) Define the term codeword. With respect to codewords, what is the Hamming distance? Explain the relevance of Hamming distance to error detection. (7 marks)

(b) Consider the following DTD fragment:

```
<!ELEMENT article     (author*, title, type?)>
<!ELEMENT author      (first-name?, last-name)>
```

i. Assume that the information about the type of article is to be represented as an attribute rather than an element, with the only allowed values for type being journal or conference. Write down an appropriate declaration for the type attribute. (3 marks)

ii. Assuming type is an attribute of article, write an XPath expression to find those conference articles having more than three authors. (4 marks)

iii. Explain why the relative XPath expression

```
article[author/first-name][author/last-name]
```

is equivalent to the expression `article[author/first-name]` on documents valid with respect to the above DTD fragment. (3 marks)

(c) Describe three ways in which XSL provides a more powerful stylesheet mechanism for XML than CSS does. (3 marks)

2. (a) Explain what it means to say that an XML document is invalid. (3 marks)

(b) 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.) (5 marks)

(c) If you were asked to include on a web page functionality similar to that provided by Google’s search-suggest, describe what principal components and/or mechanisms you would use to achieve this. Do not include any code in your answer. (5 marks)

(d) Explain how TCP implements flow control. (7 marks)
3. (a) Consider the following fragment of XML:

```xml
<product xmlns="http://www.xxx.com">
  <manufacturer>
    <name xmlns="http://www.yyy.com"> ... </name>
  </manufacturer>
  <description xmlns="http://www.zzz.com"> ... </description>
  <price> ... </price>
</product>
```

For each of the elements product, manufacturer, name, description and price, state which namespace it is in. (5 marks)

(b) Explain the function of the DOM method `getElementByTagName`. If such a method were not provided, what other DOM methods could be used and how would they be used to provide similar functionality? (5 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 X, Y and Z 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.

<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 B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B sends to A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X broadcasts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y sends to A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y sends to X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X sends to Z</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z sends to X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(7 marks)

(d) A network on the Internet has a subnet mask of 255.255.240.0. What is the maximum number of host machines it can handle? Justify your answer. (3 marks)

4. (a) Explain the relationships among URIs, URNs and URLs. (4 marks)

(b) Consider a situation in which a cyber-terrorist makes all the DNS servers in the world crash simultaneously. How would this change one’s ability to use the Internet? (5 marks)

(c) Design a form in HTML which requests the user to type in two numbers. When the user clicks the submit button, the server returns the product of the two numbers. Write the server-side page as a PHP script. (7 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 output after stuffing? (4 marks)

5. (a) Give the full names of the application-layer protocols SMTP, POP3 and IMAP4, along with a description of the purpose of each. (5 marks)

(b) Consider an application where information about music recordings is represented in an XML file.

i. A recording element has the following content model. It comprises an artist element followed by one or more track elements, where each track element contains a title element followed by an optional length element. Write down the necessary DTD element declarations which satisfy these requirements. (7 marks)

ii. Now produce a template rule for an XSLT stylesheet which will match a recording element (as defined in Part 5(b)i) and will output an HTML table, with one row for each track. Each row should contain the track number, the track title and the artist. (8 marks)

6. (a) Give the two main types of entities used in XML, and distinguish between their syntax and usage. (5 marks)

(b) Explain the differences in meaning between the following two XPath expressions: (i) //section[//image], and (ii) //section[./image]. (3 marks)

(c) Explain the concept of multiplexing with respect to a communication medium. Name two types of multiplexing, along with the basic principal behind how each works. (6 marks)

(d) Sketch the Manchester encoding on a classic Ethernet for the following bit stream: 0001110101. (3 marks)

(e) The standard HTTP URL syntax assumes that the Web server is listening on port 80. However, it is possible for a Web server to listen on another port. Describe the syntax for a URL referring to a file on a non-standard port. (3 marks)
7. (a) Consider an XML document with the following structure:

```xml
<proceedings>
  <name>Some conference</name>
  <contents>
    <article>
      ...
    </article>
    ...
  </contents>
</proceedings>
```

along with an XSLT stylesheet in which the only template rule is the following:

```xml
<xsl:template match="name">
  <html><h1><xsl:value-of select="."/></h1></html>
</xsl:template>
```

Describe the output produced when the XSLT stylesheet is applied to the XML document, and explain why this output is produced. (8 marks)

(b) 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)

(c) A router has the following (CIDR) entries in its routing table:

<table>
<thead>
<tr>
<th>Address/mask</th>
<th>Next hop</th>
</tr>
</thead>
<tbody>
<tr>
<td>135.46.56.0/22</td>
<td>Interface 0</td>
</tr>
<tr>
<td>135.46.60.0/22</td>
<td>Interface 1</td>
</tr>
<tr>
<td>192.53.40.0/23</td>
<td>Router 1</td>
</tr>
<tr>
<td>default</td>
<td>Router 2</td>
</tr>
</tbody>
</table>

Consider the following IP addresses:

i. 135.46.63.10
ii. 135.46.57.14
iii. 135.46.52.2
iv. 192.53.40.7
v. 192.53.56.7

For each address, which next hop does the router choose when it receives a packet with that address? (5 marks)

(d) Why does UDP exist? Would it not have been enough just to let user processes send raw IP packets? (3 marks)