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. (a) Consider representing data about published articles in XML format, where a Document Type Definition (DTD) needs to be produced to capture the following requirements. An article has one or more authors, a title, a year of publication and optional information about pages. In addition, the article is published in a journal, book or conference. A journal has a title and either just a number or both a volume and number. A book has a title and zero or more editors. A conference has a title and venue. Write down DTD element declarations for only the article, journal, book and conference elements.

   (10 marks)

(b) Describe the main difference between a broadcast channel and a point-to-point channel. What is the consequence of this difference? List three different types of protocols which are used on broadcast channels in order to address the issue raised by this difference.

   (6 marks)

(c) Explain why it is not necessarily the case that each machine connected to the Internet has only a single assigned IP address.

   (4 marks)

2. (a) A number of IP addresses are reserved for special purposes. Describe these (sets of) addresses (in terms of the IP addresses involved) as well as the purpose each serves.

   (10 marks)

(b) Explain how the values entered into HTML form fields are retrieved by a PHP script running on a server. (You do not have to write any PHP code.)

   (6 marks)

(c) Javascript provides an XMLHttpRequest object. Explain what functionality is offered by this object. You should make reference to two methods or properties of the object in your explanation.

   (4 marks)
3. Consider the following XSLT template rule:

1. <xsl:template match="div[@class='slide']">
2.   <xsl:variable name="section">
3.     <xsl:number count="div[@class='slide']"/>
4.   </xsl:variable>
5.   <xsl:for-each select="*">
6.     <xsl:choose>
7.       <xsl:when test="name()='h1'">
8.         <h2>
9.           <xsl:value-of select="$section"/>
10.          <xsl:value-of select="."/>
11.         </h2>
12.       </xsl:when>
13.       <xsl:otherwise>
14.         <xsl:copy-of select="."/>
15.       </xsl:otherwise>
16.     </xsl:choose>
17.   </xsl:for-each>
18. </xsl:template>

Assume that the rule is part of a stylesheet applied to an XHTML document.

(a) What is the name given to the string xsl: which appears in most start and end tags? Why does it not appear in the h2 start and end tags? (2 marks)

(b) Write down the start tag for an element in the source XHTML document which will be matched by the above rule. (3 marks)

(c) Explain what happens when the variable construct is executed (lines 2 to 4). (4 marks)

(d) Which elements are selected by the * in the fifth line? (3 marks)

(e) Describe the transformation applied by the instructions within the choose construct (lines 6 to 16). (8 marks)
4. (a) The following fragments are taken from the HTML 4.01 Document Type Definition (DTD):

<!ENTITY % StyleSheet "CDATA">
<!ENTITY % Text "CDATA">
<!ENTITY % coreattrs
"id" ID #IMPLIED
class CDATA #IMPLIED
style %StyleSheet; #IMPLIED
title %Text; #IMPLIED">

<!ELEMENT BR EMPTY>
<!ATTLIST BR
%coreattrs;>

i. What is the name given to the entity types used above, and what distinguishes them syntactically from general entities?  

(2 marks)

ii. Why are such entity declarations considered useful in this context?  

(2 marks)

iii. Write down the ATTLIST declaration for the BR element after all entity references have been dereferenced.  

(3 marks)

(b) In the Domain Name System (DNS), there are 13 root DNS servers.

i. What is the function of these root servers?  

(3 marks)

ii. Explain why only 13 root servers (even if each is actually a cluster) are sufficient for all the DNS requests being made on the Internet.  

(4 marks)

(c) Explain the representation and use of protocol port numbers on the Internet.  

(6 marks)
5. (a) Explain how the Transmission Control Protocol (TCP) implements flow control.

(b) Consider a home router which is connected to an Internet Service Provider (ISP). The ISP has allocated the IP address 138.76.29.7 to the router. The router implements Network Address Translation (NAT) and has the following NAT table, currently containing only a single entry:

<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, 3345</td>
</tr>
</tbody>
</table>

i. The router receives a TCP segment with destination port number 5001 from the ISP. Explain precisely how the router modifies the segment using NAT.

ii. Now the router receives a TCP segment with source port number 7668 from the machine with IP address 10.0.0.1. Explain what the router does.

(c) Explain why Manchester encoding uses rising and falling edges to encode bits.

6. (a) Explain how IP datagram fragmentation can arise and how it is handled by IP.

(b) HTTP 1.1 can use pipelining over a persistent connection. Explain what is meant by the two italicised terms in the previous sentence, as well as how each improves what is available in HTTP 1.0 (which does not provide persistent connections).
7. (a) Consider the following fragment of HTML which also contains some JavaScript:

```html
<form>
  <label>Enter a word:</label>
  <input type="text" id="word" />
  <input type="button" value="Click here"
    onClick="result.value=function (w) {
      if (w === 'hello')
        return('goodbye');
      else
        return('unknown');
    }(word.value)" />
  <input type="text" id="result" />
</form>
```

i. Draw (roughly) or describe how the HTML form would be rendered in a browser. (3 marks)

ii. Explain what would happen if the user entered hello in the lefthand text box and then clicked on the button. (2 marks)

iii. Explain what would happen if the user cleared the lefthand text box, entered goodbye in the righthand text box, and then clicked on the button. (2 marks)

(b) The Transmission Control Protocol (TCP) responds to the loss of segments (packets) by retransmitting them. Explain how TCP adapts its behaviour in this respect according to the speed of the transmission medium being used. (7 marks)

(c) Consider using XPath expressions to determine whether certain invalid combinations of elements are present in an XHTML document. For each of the following, write down an XPath expression which selects the elements specified:

i. Paragraph (p) elements which are nested inside other paragraph elements. (3 marks)

ii. List item (li) elements which do not have either an ordered list (ol) or an unordered list (ul) element as a parent. (3 marks)