There are five questions on this paper.
Answer only four of the five questions.
If you answer more than four questions, only the best four answers will count.
Each question carries 25 marks in total.
The paper is not prior-disclosed.
The use of electronic calculators is not permitted.
1. (a) The TCP/IP protocol stack consists of a number of layers. Name each layer and describe its main function.

(10 marks)

(b) Consider the following (simplified) DTD (Document Type Definition) for representing information about online auctions, where `open_auctions` is the document (root) element:

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

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. There are no bidders for the second auction.

<table>
<thead>
<tr>
<th>Seller</th>
<th>Initial price</th>
<th>Bidder</th>
<th>Bid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jack</td>
<td>20</td>
<td>Lucy</td>
<td>30</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.

(15 marks)
2. (a) Consider representing the results of rugby (union) matches in XML. Each match is between two teams. Each team has a name (a string), and a sequence of point-scoring events, namely tries, conversions and penalties. It should be the case that these events can occur in any order. Each try, conversion and penalty should record the name of the player involved. Write down a set of Document Type Definition (DTD) element declarations which satisfy the requirements described above.

(b) Given an XML document satisfying the requirements of the DTD in Question 2a, write down XPath expressions to perform each of the following operations (assuming no initial context):
   i. Count the number of tries scored by the player named “Jones”.
   (5 marks)
   ii. Select the names of teams which scored no tries, conversions or penalties.
   (5 marks)

(c) TCP is said to use an adaptive mechanism to decide whether a segment it sent has been lost. In what way does it adapt its behaviour?

   (5 marks)

3. (a) A URI can include a question mark character in it. Explain the syntax of the information that follows the question mark as well as when this feature is used by HTTP.

   (5 marks)

(b) JSON provides a syntax for representing data on the web. What does the acronym JSON stand for? List the primitive data types provided by JSON.

   (5 marks)

(c) Explain what is meant by pipelining in the context of HTTP (the hypertext transfer protocol). Describe advantages of pipelining, as well as consequences for an HTTP server which uses pipelining.

   (5 marks)

(d) The header of a TCP segment contains the fields SYN, FIN and Receive window. Explain briefly what each of these fields is used for.

   (5 marks)

(e) An ethernet frame can be divided into a number of parts: preamble, header, payload, and CRC. Describe what information is carried in each part.

   (5 marks)
4. (a) Unicode provides an encoding for so-called non-keyboard characters. What mechanism is provided to allow the inclusion of such characters in (X)HTML documents? You should also specify the syntax used.

(5 marks)

(b) Consider using the $.get() method of the jQuery library to read an XML file from the server. What three arguments would be expected by the method? How can the returned data be accessed?

(5 marks)

(c) Explain the difference between the functions of routing and forwarding on the Internet, as well as in what way they are connected.

(5 marks)

(d) One category of multiple access protocols are the taking-turns protocols. Name two such protocols and describe in general terms how each operates as well as any problems inherent in their designs.

(10 marks)

5. (a) Consider the following CSS rule:

```css
pre span.keyword, code span.keyword { color: red; }
```

Explain in detail the effect of the above rule when applied to an HTML document.

(5 marks)

(b) Explain in detail what the innerHTML property of a DOM element can be used for. In the following Javascript statement

```javascript
element.innerHTML = ...;
```

what type of value is expected on the right side of the assignment? Explain what the browser does when executing the statement.

(5 marks)

(c) Name 5 different server-side processing technologies.

(5 marks)

(d) The TCP protocol is sometimes referred to as a stream-oriented protocol. Explain what is meant by this term, as well as some of the functionality required in client and server programs which implement such protocols.

(5 marks)

(e) Given a CIDR IPv4 address 200.23.16.0/22, write down in dotted decimal notation the full range of IP addresses that could be assigned to machines on the subnet. Explain how you obtained your answer.

(5 marks)