1. (a) The physical layer corresponds to the basic network hardware. The network interface, or link, layer specifies how data is divided into packets. The Internet layer specifies how packets are forwarded to particular machines over the Internet, using the Internet Protocol (IP). The transport layer specifies how to communicate with particular processes on machines, using the Transmission Control Protocol (TCP) or User Datagram Protocol (UDP). The application layer specifies how applications use the Internet, and includes protocols such as the HyperText Transfer Protocol (HTTP) and the Domain Name System (DNS).

(10 marks)

(b) The type of content model is called mixed. The allowed content for p elements is text interspersed with any number of em, img or b elements.

(4 marks)

(c) The first invocation of the $ function finds the element identified by the CSS selector #target1. The append method adds a new last child to elements on which it is invoked. The function $ creates a new element when passed a string representing an empty element as first argument. The second argument is an object comprising property-value pairs. The text property is interpreted as the textual contents of the element, so a new li element with contents “Hello” is appended.

(6 marks)

2. (a) The action attribute takes a URI as its value. The method attribute takes an HTTP method, such as GET or PUT as value. When a user clicks on a submit button for the form, the corresponding HTTP method is invoked, using the URI specified. Input values from the form are sent to the resource specified by the URI, either as a query string (GET) or as the message body (POST).

(4 marks)

(b) TCP uses a window mechanism to control the flow of data. When a connection is established, each end of the connection allocates a buffer to hold incoming data, and sends the size of the buffer to the other end. As data arrives, the receiver sends acknowledgements together with the amount of buffer space available,
called a window advertisement. If the receiving application can read data as quickly as it arrives, the receiver will send a positive window advertisement with each acknowledgement. However, if the sender is faster than the receiver, incoming data will eventually fill the receiver’s buffer, causing the receiver to advertise a zero window. A sender which receives a zero window advertisement must stop sending until it receives a positive window advertisement.

(10 marks)

(c) The cost to B is 1, to C is 2, to D is 3, and to E is 3. For traffic destined for D, the initial link would be (A,C). For traffic destined for E, the initial link would be (A,C).

(6 marks)

3. (a)  

3. (a)  

<code>  
<xsl:template match="/html">  
  <html>  
    <head>  
      <xsl:for-each select="head/*">  
        <xsl:copy-of select="."/>  
      </xsl:for-each>  
    </head>  
    <body>  
      <ol>  
        <xsl:for-each select="body/div[@class='chapter']/h1">  
          <li><xsl:value-of select="."/></li>  
        </xsl:for-each>  
      </ol>  
    </body>  
  </html>  
</xsl:template>  

(16 marks)

(b) A bridge is used to connect two LAN segments. It handles complete frames. when it receives a frame on one segment, it verifies that the frame arrived intact and, if so, forwards it to the other segment if necessary.

(4 marks)

4. (a) An <i>absolute expression</i> starts with an initial “/” and is evaluated starting at the special root node of the document. A <i>relative expression</i> does not start with a “/” and is evaluated with respect to a <i>context</i>, which must be established externally or by a previous location step in the same expression.

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Pipelining can be used over a persistent HTTP connection. It allows a client to make multiple requests to a server without waiting for each response, and results in better utilisation of the connection. The server can process the requests concurrently. In principle, the server could send responses to the client in the order in which the requests complete which would minimise waiting times. However, HTTP has no way of identifying a response with a request, so the specification states that the server must send responses in the same order as requests arrive.

A recipient could automatically correct a single bit error as follows. If 001, 010, or 100 is received, the original message was 0. If 110, 101, or 011 is received, the original message was 1. The problem with this method is that the transmitted message is three times longer than the original, and there are other methods which involve less redundancy.

Channel partitioning protocols divide up a channel using multiplexing. Random access protocols allow each node to transmit at the full rate of the channel and then handle collisions. Two examples of the former are frequency division multiplexing and time division multiplexing. One example of the latter is Ethernet.

An XML namespace declaration takes the form of a special attribute used on an element start tag as follows:

```xml
<... xmlns:svg="http://www.w3.org/2000/svg">
```

The attribute name start with `xmlns`. If there is a prefix associated with the namespace (e.g. `svg`), this follows after `:`. If the default namespace is being declared, there is no prefix or `:`.

XSLT is a much more powerful language than CSS. It allows for element reordering, selection of only certain elements, sorting elements in the output, processing elements more than once, and output of arbitrary text or elements not present in the input.

TCP uses cumulative acknowledgements. (ii) Host A does not retransmit if the timeout interval expires after $t_3$ because it has received the acknowledgement from Host B that it has received all 119 bytes in the two segments. (iii) If the interval had expired before $t_2$, Host A would have retransmitted the segment with sequence number 92 before transmitting the segment with sequence $c$. 

(c) (i) TCP uses cumulative acknowledgements. (ii) Host A does not retransmit if the timeout interval expires after $t_3$ because it has received the acknowledgement from Host B that it has received all 119 bytes in the two segments. (iii) If the interval had expired before $t_2$, Host A would have retransmitted the segment with sequence number 92 before transmitting the segment with sequence $c$. 

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number 100. (iv) If the interval had expired after \( t_2 \) but before \( t_3 \), Host A would have retransmitted the segment with sequence number 92 after transmitting the segment with sequence number 100.

(7 marks)

6. (a)  
```xml
<!ELEMENT matches (match)+ >
<!ELEMENT match (team, team) >
<!ELEMENT team (name, (goal | booking)*) >
<!ELEMENT name (#PCDATA) >
<!ELEMENT goal (player, time) >
<!ELEMENT booking (player, time) >
<!ELEMENT player (#PCDATA) >
<!ELEMENT time (#PCDATA) >
<!ATTLIST booking type (yellow|red) "yellow" >
```

(12 marks)

(b) DNS names are organised hierarchically: the most significant part of the name on the right, with the left-most segment being the name of an individual computer. DNS is essentially a distributed database implemented as a hierarchy of DNS servers. It is also an application-layer protocol allowing hosts to query the database. There are 13 root DNS servers (replicated) which return IP addresses of top-level domain servers. The top-level domain servers are responsible for top-level domains. They return IP addresses of authoritative servers for organisations. Each organisation must provide an authoritative DNS server for its publically accessible hosts. Each DNS server contains information linking it to other DNS servers up and down the hierarchy.

(8 marks)

7. (a) DTDs use non-XML syntax, there is no data typing, especially for element content, they are only marginally compatible with namespaces, they cannot use mixed content and enforce the order and number of child elements, it is clumsy to enforce presence of child elements without also enforcing order (i.e. no & operator from SGML), and element names are global.

(6 marks)

(b) The first line retrieves the value of the form text box identified by `id="txtSearch"` and URL-encodes it using the `escape` function. The second line sets up an asynchronous connection using the HTTP GET method with the `searchSuggest` PHP file on the server, passing the value entered as a query string. The third line specifies the call-back function (`handleSearchSuggest`) to call when `readyState` changes. The fourth line sends the HTTP GET request with an empty message body.
(c) The time-to-live header is initialised by the sender. It is decremented by one at each router that handles the IP datagram. When it reaches zero, the datagram is discarded by the router, and the sender notified with an ICMP message.