This paper comprises seven 20-mark questions. Candidates must answer exactly FIVE questions. Calculators are not permitted. The paper is not prior-disclosed.
1. (a) Explain the differences between the stream and message communication paradigms found on the Internet. 

(10 marks)

(b) The operators ? and + in document type definition (DTD) syntax allow one to write shorter expressions than if one had to use only the remaining DTD operators. For each of the expressions (i) (name)? and (ii) (name)+, give equivalent expressions which do not use either ? or +.

(4 marks)

(c) What is the name of the general character encoding scheme used to encode characters from all the world’s languages, and what is the particular form of it used in XML? Explain the syntax used to include in an XML document characters other than those available on a standard keyboard.

(6 marks)

2. (a) What is base64 encoding used for?

(2 marks)

(b) Describe in what format data entered into HTML form fields is sent to the server. Explain, using either CGI or PHP, how server-side scripts retrieve the form data.

(8 marks)

(c) Describe briefly how the transmission control protocol (TCP) implements congestion control.

(4 marks)

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

(6 marks)
3. (a) Explain the purpose of the *Address Resolution Protocol* (ARP) and describe briefly how it works.  

(b) Consider an XML file containing recipes. The document element is `recipes`. This contains any number of `recipe` elements, each of which contains a `name`, one or more `ingredients`, and a `method`. Each `ingredient` has a `quantity` and a `description`. All the information is represented using elements. Write down one or more XSLT template rules (do not include the stylesheet element itself) which will output the following HTML document. The document should contain all recipes in which chocolate is one of the ingredients (you can assume that the description of such an ingredient will always be the string “chocolate” so that you do not have to worry about substring matching). There should be an `h1` heading with the value “Recipes with chocolate.” The name of each recipe containing chocolate should form an `h2` heading. For each such recipe, the name of the recipe should be followed by a table of ingredients, with each row containing the quantity and description of each ingredient. The table should be followed by a `p` (paragraph) element containing the method.

4. (a) Consider the use of an XML vocabulary for representing the results of events at the Olympics. The results for any number of events are to be represented in a single document. Each event has a name (which is just text) and one or more athletes who participated in the event. Each athlete has a name (text) and a country (text) which they represented, as well as an optional position in which they finished (a missing position means that they did not finish). Optionally associated with a position is a medal whose value must be one of *gold*, *silver* or *bronze*.

i. Write down a document type definition (DTD) which captures the above requirements.

ii. Assuming you are given a document conforming to the DTD you produced for Question 4(a)i, write down an XPath expression which will count the number of gold medals won by athletes who represented Great Britain.

(b) Explain what is meant by the *maximum transmission unit* (MTU) for a network. What problems does this cause the Internet, and how does IP handle this?
5. (a) The XML namespaces specification allows for associating namespaces with particular prefixes or for assigning a default namespace. Explain how namespace definitions can be overridden. Explain also why overriding namespace definitions is not considered to be best practice. 

(b) Explain what problem Network Address Translation (NAT) is designed to solve and how it does so. What criticisms have been levelled at NAT?

6. (a) Empty elements are not required to have end tags in HTML whereas they must have end tags in XHTML. Explain why.

(b) When using the XMLHttpRequest object in Javascript, the resource being requested must come from the same domain as the page containing the Javascript code. Explain in broad terms how you could circumvent this restriction and therefore retrieve resources from anywhere. (No code is necessary in your answer.)

(c) Describe (preferably 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.

7. (a) In XML documents, explain why it is preferable to use an external rather than an internal document type definition (DTD).

(b) Assume that you want to use Javascript to delete an element from the document currently displayed in the browser. Explain conceptually (rather than writing code) how you would do this, mentioning any document object model (DOM) method(s) you might use.

(c) One of the blocks of IP addresses reserved for private networks is identified by 172.16.0.0/12. Explain what this notation means and identify the smallest and largest IP addresses within such a private network, showing how you derived these answers. Can all of the addresses in the range be allocated to individual machines? Explain your answer.