This paper comprises seven questions in two sections, A and B. Candidates must answer exactly FIVE questions, with at least TWO questions from each of Section A and Section B. Calculators are not permitted.
Section A: Internet Technologies

(Answer at least TWO questions from this section.)

1. (a) Describe briefly (preferably with the aid of diagrams) the three principal topologies used to construct conventional Local Area Networks (LANs). (3 marks)

(b) Long-distance communication systems send a continuously oscillating signal called a carrier. Describe briefly (preferably with the aid of diagrams) two forms of modulation for encoding a signal on the carrier. (2 marks)

(c) An Ethernet LAN uses Manchester Encoding to transmit Ethernet frames across the network. Describe briefly (preferably with the aid of a diagram) how this works. (5 marks)

(d) Describe briefly (preferably with the aid of a diagram) the structure and fields of an Ethernet frame. (3 marks)

(e) Describe briefly (preferably with the aid of a diagram) how computers use Ethernet's Carrier Sense Multiple Access/Collision Detection (CSMA/CD) to coordinate their communications. (3 marks)

(f) Repeaters are a cheap mechanism for expanding an Ethernet LAN. These have largely been replaced by Ethernet bridges. Describe the advantages bridges have over repeaters. (4 marks)
2. The following diagram illustrates the fields in an IP datagram.

(a) Describe briefly (preferably with the aid of a diagram) the five classes of original IP addresses, known as classful IP addressing. (4 marks)

(b) Classless addressing uses a 32-bit IP address and an additional 32-bit subnet mask to indicate where the boundary occurs between the network prefix and the host suffix. This pair is written using Classless Inter-Domain Routing (CIDR) notation. How would the (original) class C network address 192.191.190.0 be written using CIDR notation? (3 marks)

(c) A router receives a datagram with the TIME TO LIVE field containing the value one. What actions should the router take? (3 marks)

(d) A router receives a datagram with the DON’T FRAGMENT flag set, but the router needs to fragment the datagram for its next hop. What actions should the router take? (3 marks)

(e) A computer receives a datagram with a non-zero FRAGMENT OFFSET field and the MORE FRAGMENTS flag unset. What actions should the computer take? (4 marks)

(f) An Internet Service Provider (ISP) is providing one of their clients with a block of eight IP addresses starting at address 192.191.190.0. Show the subnet mask that should be used with this block. In addition, show the first and last unicast addresses available to the client. (3 marks)
3. The following diagram illustrates the format of a Transmission Control Protocol (TCP) segment.

(a) Describe briefly the seven major features of TCP. (4 marks)
(b) The TCP/IP protocol suite also includes another protocol at the transport layer, namely the User Datagram Protocol (UDP). Explain briefly why there is the need for both TCP and UDP. (5 marks)
(c) Name three application protocols that use TCP for data communication. (3 marks)
(d) Name three application protocols that use UDP for data communication. (3 marks)
(e) An organisation’s gateway machine uses Network Address and Port Translation (NAPT) to map internal sockets (IP address plus port number) to external sockets. Describe briefly why this is required, and give an example translation table using the private (internal) IP network 192.168.1.0 and an outward-facing IP address of 192.191.190.3. (5 marks)
Section B: Web Technologies

(Answer at least TWO and at most THREE questions from this section.)

4. (a) Why is the XML document format becoming very popular in many application areas? (4 marks)

(b) The following is a possible XML document (calendar.xml) for recording entries in an individual’s on-line calendar.

```xml
<?xml version="1.0"?>
<!DOCTYPE calendar SYSTEM "calendar.dtd">

<calendar>
  <year value="2011">
    <date month="01" day="12">
      <event time="1100">
        Web technology (1)
      </event>
    </date>
    <date month="01" day="19">
      <event time="1100">
        Web technology (2)
      </event>
    </date>
    <date month="01" day="26">
      <event time="1100">
        Web technology (3)
      </event>
      <event time="1600">
        Teaching Committee (Room 734)
      </event>
    </date>
  </year>
</calendar>
```

The line numbers are not part of the document, they are there for your use. Describe briefly what each line, or group of lines, represents. (4 marks)

(c) The structure of an XML document for a particular vocabulary, or application area, has to agree with a set of syntax rules. These are provided in the form of a Document Type Definition (DTD) document. If the XML document conforms to the rules in the DTD document it is considered to be valid. Write a DTD
document (calendar.dtd) for the example from the calendar vocabulary, given above. (6 marks)

(d) In the context of DTDs, explain what is meant by a mixed content model. Describe the syntactic restrictions placed on mixed content models in a DTD declaration and explain what effect these restrictions have. (6 marks)
5. (a) What constraints should a document satisfy if it is going to be valid with respect to a DTD which declares attributes of type ID and IDREF? (2 marks)
(b) Element tags in different vocabularies may share the same name. Describe briefly how this is overcome using *namespaces*. (2 marks)
(c) Describe the syntax used for declaring a namespace in an XML document. How are elements declared to be in the particular namespace declared? (4 marks)
(d) You are writing Javascript code using the *Document Object Model* (DOM) which needs to work in both Firefox and Internet Explorer. Describe three functions which are implemented differently by these browsers. (6 marks)
(e) For one of the three functions mentioned above, write a fragment of Javascript code that demonstrates how the Javascript distinguishes between the two browsers. (6 marks)
6. (a) What is an XML entity? Distinguish between a general entity and a parameter entity. Give an example of a general entity declaration, followed by a reference to the same entity. (10 marks)

(b) Recall that in HTML list-item (li) elements occur as children of either ordered (ol) or unordered (ul) list elements. Furthermore, list-item elements can themselves contain ordered or unordered lists (so lists can be nested). Given an HTML document, write down XPath expressions that will return the following.

i. all list-item elements in the document (1 mark)

ii. the ordered-list elements containing a nested unordered-list element (2 marks)

iii. the ordered-list elements that have only a single list-item within them (3 marks)

iv. the list-item elements that are both children of an ordered-list element and have no lists nested in them (assume that ordered and unordered lists are the only possibilities) (4 marks)
7. Consider an XML document used to store information about a person’s collection of books. The document (root) element is named `library`. This element has any number of `book` elements as children. Each `book` element has a `title` child element, which is followed optionally by one or more `author` elements (giving the names of the authors of the book), which are followed by an optional `isbn` element, which is followed by an optional `cover` element which is empty.

The `cover` element has a mandatory `ref` attribute, whose value is a URL giving the location of the cover image. All other elements contain text.

(a) Write a DTD document describing the syntax of the `library` vocabulary. (6 marks)

(b) Write an XSLT stylesheet that will transform an XML document valid with respect to the above DTD into an HTML document with the following characteristics.

There is a heading “My Library”. This is followed by the books organised in a table, with one book per row. Each row contains the title of the book, the names of the authors in a column, the ISBN number, and the cover photo. (14 marks)