CS-238
DATA COMMUNICATIONS AND COMPUTER NETWORKS
Attempt 2 questions out of 3

Question 1

(a) In the ISO 7-layer model (the reference model for OSI), which layer(s) would you expect to be responsible for each of the following?

   (i) Bit stuffing

   (ii) Congestion control

   (iii) Data compression

   (iv) Analogue to digital conversion

   (v) Reliable data transfer

   (vi) Packet routing

   (vii) Email transport

   (viii) CSMA/CD.

[4 marks]

(b) (i) In the context of packet routing algorithms, describe the flooding algorithm, and a technique for preventing the generation of vast numbers of duplicate packets.

   (ii) Explain how the flooding algorithm can be used to construct path tables for the shortest path routing algorithm.

[6 marks]

(c) (i) HTTP v1.0 as defined in RFC 1945 performs one transaction per object requested. Explain the two mechanisms introduced in HTTP v1.1 to overcome the inefficiency of this arrangement. Your discussion should include an examination of issues surrounding Round Trip Time.

   (ii) Briefly outline how HTTP uses cookies to simulate stateful connections.

[6 marks]

(d) (i) Assume that the data bits 110011010 are to be transmitted. Create the total transmitted codeword if the Hamming single bit code is used for error detection, counting the bits from left to right.

   (ii) Assume that the 5th bit from the right was inverted during the data transmission. Show step by step how the Hamming Single Bit Code can be used to detect and correct the transmission error.

   (iii) How can the single Hamming bit code method be adapted to detect and correct burst errors of length 6 when codewords (including redundant data) have a length of 10 bits?

   How many message bits are transmitted if each codeword (including check bits) consists of 10 bits?

[9 marks]

Question 2

(a) Given the following 46 bit binary stream, compress the string into a sequence of 3-bit symbols/numbers using Binary 0-Run Length Encoding. What compression ratio would you achieve in this case? Assume that all streams start with a `0` and end with a `1` (before compression).

```
 0-runs:    |--5--|---7---|-3-|  |-------15------|-2|---6--|
bit string:   0000010000000100011100000000000000010010000001
```

[5 marks]

(b) ADSL is a popular choice for providing broadband network services to households and small businesses. Give one reason why this is the case from the point of view of each of the following:

   - The telecommunication company (telco);
   - the consumer.

Give two disadvantages of the system from the telco's point of view.

Explain how ADSL is able to offer speeds of the order of 1Mbps over telephone lines which have previously only been usable at 56kbps.

What is the difference between ADSL and SDSL, in terms of the distribution of channels within the total available bandwidth?

[5 marks]

(c) (i) The *Manchester encoding* scheme encodes 0 with a high-to-low transition in the middle of an interval, and 1 with a low-to-high transition in the middle of an interval. Represent the bit stream **01001101** using Manchester encoding, assuming that the signal is at the low level in the beginning. The duration of each bit must be clearly indicated in your representation.

   (ii) The *differential Manchester encoding* scheme always encodes a transition in the middle of an interval. In addition, it encodes 0 with a transition at the beginning of an interval, and 1 without. Represent the bit stream **01001101** using differential Manchester encoding with the same assumption as above. Briefly discuss the relative merit(s) of differential Manchester encoding in comparison with Manchester encoding.

   (iii) In each token ring (IEEE 802.5) frame, all information bits are encoded using Manchester encoding, except the start and end delimiters. Explain the advantage(s) of departing from the normal encoding rules for the delimiters.

[7 marks]

(d) In a subnet as shown below, a packet arrives at node G on the channel BG (from B to G), and has node P as its final destination. Inside node G, the number of packets queueing up for each channel is:

GB: 2	GC: 7	GJ: 9	GN: 5

Node G has also recorded the hop count of the last packet that arrived on each channel from node P as:

BG: 7	CG: no record	JG: 5	NG: 6

Consider each of the following algorithms. On which channel(s) would node G send out the packet? Briefly explain your answers.

 (i) Shortest path algorithm which measures the number of hops;

 (ii) backward learning algorithm which measures the number of hops;

(iii) hot potato algorithm;

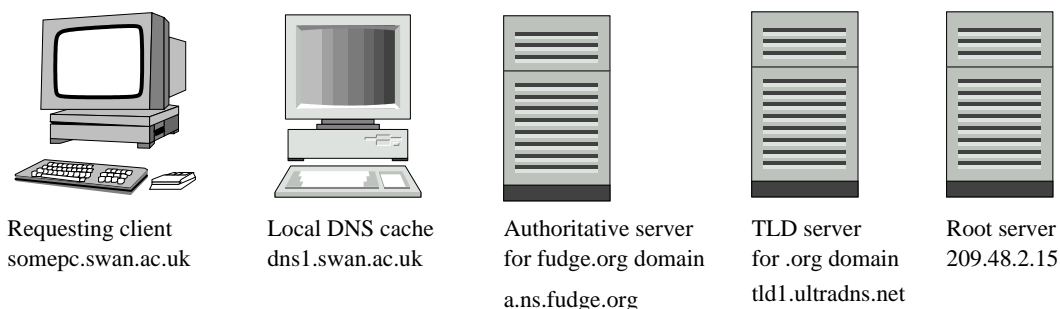(iv) flooding algorithm.
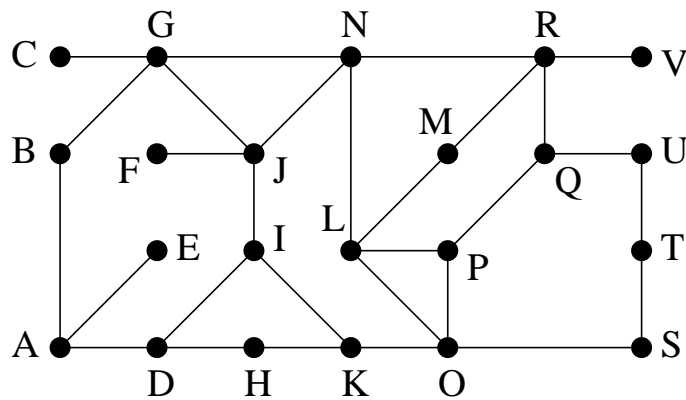
[8 marks]

Question 3

(a) (i) With the aid of one or more diagrams, describe circuit switching and packet switching, and the differences between them.

(ii) Briefly outline the idea of a virtual circuit.

[8 marks]

(b) (i) A process running on the host `somepc.swan.ac.uk` wishes to look up the IP address of the host `catnip.fudge.org`. The following diagram illustrates a number of hosts involved in this process, and is followed by a number of resource records extracted from the authoritative information held on `a.ns.fudge.org`.

Requesting client
somepc.swan.ac.uk

Local DNS cache
dns1.swan.ac.uk

Authoritative server
for fudge.org domain

a.ns.fudge.org

TLD server
for .org domain
tld1.ultradns.net

Root server
209.48.2.15

```
; Authoritative data for fudge.org
fudge.org.   86400   IN   SOA     Hello
fudge.org.   86400   IN   MX      1 catnip.fudge.org
fudge.org.   86400   IN   MX      2 collar.fudge.org
biscuit      86400   IN   A       137.188.8.242
tuna         86400   IN   A       137.188.8.243
string       86400   IN   A       137.188.8.244
catnip       86400   IN   CNAME   biscuit.fudge.org
catnip       86400   IN   MX      1 catnip
catnip       86400   IN   MX      2 string
collar       86400   IN   CNAME   tuna.fudge.org
```
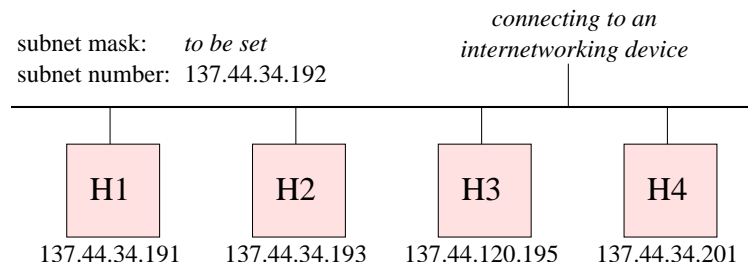
Explain the steps involved in `somepc` discovering the IP address of `catnip.fudge.org`, and state that address. Assume that all caches are empty.

(ii) Briefly, how can DNS be used to provide simple load balancing?

[6 marks]

(c) (i) A trainee network operator was given a task to set up a local area network with subnet number 137.44.34.192. He connected four hosts to the subnet, and assigned an IP address for each of the hosts, as shown below. During the process, the trainee made some mistakes. Identify all mistakes.

subnet mask: *to be set*
subnet number: 137.44.34.192

connecting to an internetworking device

| H1 | H2 | H3 | H4 |

137.44.34.191   137.44.34.193   137.44.120.195   137.44.34.201

(ii) Assign an appropriate subnet mask for this subnet, and give both decimal and binary representations of the subnet mask. With your subnet mask, what is the maximum number of hosts this subnet can accomodate?

[5 marks]

(d) (i) The plaintext:

`waydownsouththeyhaveanamefortherainandwindandfire`

is to be encrypted using a columnar transposition cipher using the key `ROUTING`. What is the resulting ciphertext?

(ii) The RSA (MIT) public key encryption method is used with the following parameters:

$\mathbf{p} = 5$,
$\mathbf{q} = 7$,
$\mathbf{n} = p * q = 35$,
$\mathbf{z} = (p-1) * (q-1) = 24$

If the private key $\mathbf{d}$ is of value 7, what would be the public key $\mathbf{e}$?

(iii) Find another pair of (different) keys neither of which is of value 7.

[6 marks]