THE UNIVERSITY OF AUCKLAND

SECOND SEMESTER, 2007
Campus: Tamaki

COMPUTER SCIENCE

Data Communications Fundamentals

(Time allowed: 45 minutes)

NOTE:

- Attempt *all* questions in the space provided.
  Extra space for answers is available on page **??**
- This mid-semester test will contribute 50% to your coursework mark,
  and 15% to your overall course mark.
  Indicated marks are out of a total of 45 marks (one per minute).
- No marks will be awarded if you merely state a correct answer. To obtain full credit, your script must clearly explain *why* your answer is correct.
- *If you require additional information in order to answer a question, you should make a reasonable assumption as required for your answer, and you should explain your assumption on your script.*

Surname: ..... Forenames: .....

Student ID: .....

Question No.	*Possible marks*	*Awarded marks*
1. Codes	8	
2. Baudot Code	7	
3 Units	6	
4. Skype	8	
5. Multiplexing	8	
6. Hidden Stations	8	
Total	45	

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1. **Codes** [8 marks]

   (a) Define the following notions:

   i. Code [1 mark]

   A code is the assignment of a unique string of characters (a codeword) to each character in an alphabet.

   ii. Prefix Code [1 mark]

   A prefix code (or prefix-free code) is a code in which no codeword is a proper prefix of another codeword.

   iii. Uniquely Decodable Code [1 mark]

   A code is uniquely decodable if the encoding of every possible cleartext using that code is unique.

   (b) Give an example of a uniquely decodable code which is not a prefix code. Justify your answer. [5 marks]

   The code $\{10, 1011\}$ is uniquely decodable because any finite sequence of codewords can be uniquely split into 10 and 1011. It is not a prefix code (10 is a proper prefix of 1011).

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2. **Baudot Code**
   Is it possible to code 36 letters and 10 digits with the Baudot code? Briefly describe how this could be done. [7 marks]

Yes, it is possible because $36 + 10 = 46 < 64 = 2^5 \times 2$ which is the maximal number of characters we can code with a 5-bit code using the extra information 11111 (shift down) and 11011 (shift up).

3. **Units** [6 marks]

   (a) What is a YB? [1 mark]

one yottabyte (YB) = 10^{24} bits

   (b) What is a YiB? [1 mark]

one yobibyte (YiB)= 2^{80} bits

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(c) Which is higher: a YB or a YiB? Justify your answer. [4 marks]

$10^{24} - 2^{80} = (10^3)^8 - (2^{10})^8 < 0$, so one YB is less than one YiB.

4. **Skype** [8 marks]

(a) What is a Skype client? [2 marks]

A Skype client (SC) (or ordinary host) is the computer of a regular Skype user connected to the network in order to communicate with other users.

(b) What is a Skype Super Node? [2 marks]

Any computer with a public IP and proper hardware configuration can be a Super Node. An SC must connect to an SN and must register itself with the Skype login server for a successful login.

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(c) In what sense Skype is self-modifiable? [4 marks]

Almost any computer (which is not behind a firewall) may turn into an SN. SNs store the addresses of up to several hundred SCs, without carrying any voice, text or file-transfer data. SN may be active or not, making Skype the network self-modifiable.

5. **Multiplexing** [8 marks]

(a) Explain what is meant by "Wave-Division" miultiplexing (WDM). [2 marks]

Several signals are sent on fibre using a different wavelength for each sigal. The different wavelengths are combined and sent on a single fibre. At the end of that fibre, the different wavelengths are separated out again.

(b) What more-general type of multiplexing is WDM an example of? [2 marks]

Frequency Division Multiplexing (FDM)

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(c) Give an example of an environment where WDM is clearly the best way to carry many different signals. [2 marks]

WDM is particularly well suited to long underseas cables, e.g. the Sothtern Cross cable. Such cables use optical amplifiers than can carry all the wavelengths, therefore adding more wavelengths into the system only requires extra equipment at the ends of the cable.

(d) Suggest another way of using optical fibre to carry many different signals over long distances. [2 marks]

Time Division multiplexing (TDM), e.g. as used in SONET

6. **Hidden Stations** [8 marks]

(a) What is the 'hidden station' problem in wireless networking? [2 marks]

Stations A and C can both receive signals from station B, but A cn't hear C. That means that C can't reliably detect collisions for packets from A.

(b) Briefly describe the protocol that 802.11 uses to avoid it. [2 marks]

This is the RTS/CTS protocol extension of 802.11. Station A sends an RTS packet and waits for base station B to reply with a CTS packet. If A receives a CTS packet it knows it should send its data packet.

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(c) The above protocol uses two different wait times, SIFS and DIFS; explain how they are used by the hosts involved in sending and receiving a message. [4 marks]

DIFS and SIFS are part of 802.11's Distributed Co-ordination Function. SIFS (short inter-frame space) is a little shorter than DIFS (distributed inter-frame space).
To send a packet a station first waits for DIFS seconds. If someone else is sending it will wait for a random time and try again, otherwise it send its packet.
When the packet reaches its destination, the receiving station waits SIFS seconds (so as to detect a possible collision) then sends an ACK packet.