Name of Candidate: ________________________________

Student ID: ______________________________________

Signature: ____

THE UNIVERSITY OF NEW SOUTH WALES

COMP3331/93331
Computer Networks and Applications
Mid-term Examination

INSTRUCTIONS TO CANDIDATES:

(1) Time allowed: 1 hour + 15 minutes (there is no separate reading time).

(2) Total number of pages: 5 (including this cover page).

(3) Total number of questions: 5. You must answer all questions. Questions are of different value. Marks are as indicated. This examination makes up **20 marks** of your final mark for this course.

(4) Do not write your answers on this paper. This paper *must be returned* at the end of the examination.

(5) IMPORTANT: There are two versions of Question 5, one for COMP3331 (undergraduate) students and the other for COMP9331 (postgraduate) students. Please attempt the correct version. You may lose all marks for the question if you solve the incorrect version.

(6) Note that if the question asks you to derive a result or perform some calculations, it is important for you to show us your intermediate steps and tell us the arguments that you have made to obtain the result. You need to note that both the intermediate steps and the arguments carry marks. Please note that we are **not** just interested in whether you can get the final numerical answer or conclusion right, but we are **more** interested to find out whether you understand the subject matter. We do that by looking at your intermediate steps and the arguments that you have made to obtain the answer. Thus, if you can show us the perfect intermediate steps and the in-between arguments but got the numerical values wrong for some reason, we will still award you marks for having understood the subject matter.

If the question asks you to give an explanation, you should aim to give a succinct and to the point answer.

(7) This is a closed book exam. UNSW approved calculators are allowed.

(8) Write all answers in **ink** except where they are expressly required. Pencils may be used only for drawing, sketching or graphical work.

(9) For **Questions 2 – 5**, if you do not wish your answer for a question to be marked, write **0.5 SYMPATHY MARK PLEASE** in the space provided for the question. If you do this you will be awarded 0.5 sympathy mark and your answer for that question will not be marked. **Note that the sympathy mark is awarded for the entire question and not individual sub-questions.**

GOOD LUCK

Question 1 Hodge-Podge (5 marks: 1 mark for each question)

Answer in 2-3 sentences at most.

(a) Assume that 10 clients (each running on a separate machine) are simultaneously communicating with a web server using HTTP1.1 with pipelining and requesting 5 objects each (do not consider a separate index page). Assume that the web server has sufficient resources to service all received requests simultaneously. How many sockets are simultaneously open on each client machine and on the web server?

On client, only one. On server, there will be 10 socket serving ten clients and an additional one that is welcome socket for TCP connetion

(b) For the question above, now assume that the 10 clients are using HTTP1.0 with parallel connections and are requesting 5 objects each (do not consider a separate index page). Assume that each client can open as many parallel connections as required and that the web server has sufficient resources to service all received requests simultaneously. How many sockets are simultaneously open on each client machine and on the web server?

Each client has 5 sockets

(c) The author of BitTorrent claims "incentives build robustness in BitTorrent." In other words, the tit-for-tat strategy ensures that all peers cooperate in the file distribution process. However, a peer can still cheat in BitTorrent, i.e., download the entire file without uploading any chunks to any other peers. How is this possible?

A selfish peer could download only from the seed (which has the entire file and thus does not need any chunks) or through the "optimistic unchoking" process when other peers give this peer a chance to download some chunks from them.

(d) Which of the following applications typically use UDP?

1. DNS
2. Bittorrent (for file transfer)
3. E-mail
4. First person shooter games
5. HTTP
6. FTP

1,4

(e) Using TCP, a sender has sent out a total of ten data segments, each containing 1000 bytes of payload. Assume that the sender's initial sequence number (ISN) is 5000. After the sender receives a packet from the receiver with ACK number 8000, how many TCP data segments (denote their sequence numbers), if any does the sender know that the receiver definitely received?

Question 2 – The Poisoning of Google (4 marks)

Alice works at a search engine startup called Searchzilla (www.searchzilla.com) whose main competitor is Google (www.google.com). She would like to crush her competitor in the "non-traditional" way by messing up with DNS servers. Recalling from her COMP3331/9331 class that DNS servers cache A and NS records from DNS replies, Alice realises she can configure the authoritative DNS server of Searchzilla (nspowned.searchzilla.com) to return incorrect results for arbitrary domains. If other DNS servers caches Alice's malicious results, they will return bad results. Help Alice complete her master plan to hijack Google's domain name by writing down exactly what Alice's name server returns upon receiving a DNS query. To be precise, what Alice wants to achieve is that when anyone on the Internet types www.google.com in their browser, they should be presented with the Searchzilla webpage rather than Google's. Assume that the Searchzilla web server (www.searchzilla.com) is running on 9.9.9.9 and the authoritative name server for Searchzilla, nspowned.searchzilla.com is running on 9.9.9.10. Recall that DNS records are of the format <name, value, type, ttl>.

(a) Can you precisely outline the steps that Alice would have to undertake to launch the aforementioned attack? You must explicitly provide the DNS records that she will have to configure and explicitly state which servers these records must be stored/updated in.

(b) What must a robust DNS server implementation do to counter this attack?

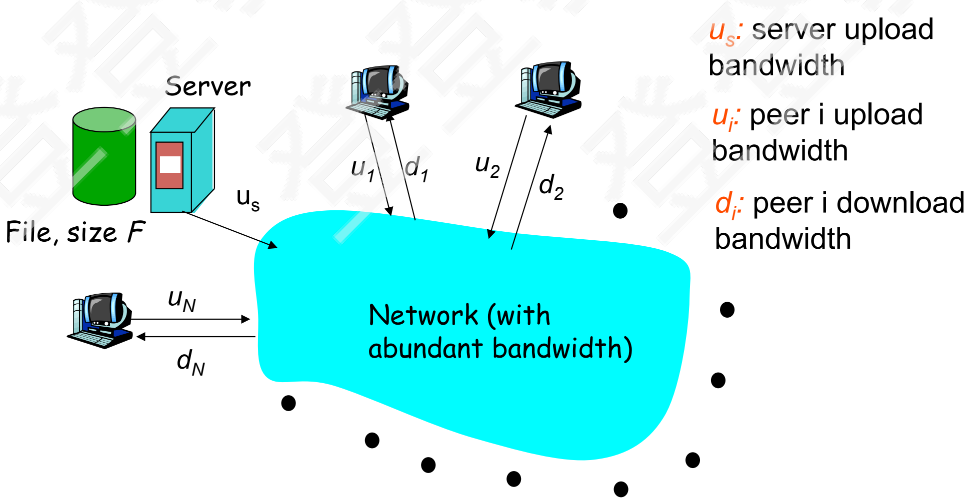
Question 3 - Oh why so selfish? (3 marks)

Consider the peer-to-peer file distribution problem illustrated in the figure below. The same problem has been discussed in the lecture slides as well as in the text. In this problem, there are N peers, and peer i has an upload transmission rate of u_i bps and a download transmission rate of d_i bps. The upload rate for the server is u_s bps. The text (and lecture slides) shows that a lower bound for the minimum time for all the N peers to download a specific file of size F bits, using peer-to-peer distribution, is:

$$D_{P2P} \geq \max\left\{\frac{F}{u_s}, \frac{F}{d_{\min}}, \frac{NF}{u_s + \sum_{i=1}^{N} u_i}\right\}$$

where $d_{\min} = \min_{i=1,2,\ldots,N} d_i$.

Note that the above expression has been derived based on the assumption that every peer is willing to upload the file (or portions of the file) after it has received it.



Now, let us assume that peers $1,2,\ldots, k$ (where k is a positive integer strictly less than N) are selfish peers which will only download files from others but do not upload any portion of the file that they have received. Derive an expression for the lower bound of the minimum time for all N peers to download the file under this revised assumption. Using the expression that you have derived, explain whether the delay when there are selfish users will be bigger or smaller than the case when all users participate in uploading.

Hint: The lower bound for the case with selfish peers is of the form

$$D_{P2P}^{\text{selfish}} \geq \max\left\{\frac{F}{u_s}, \frac{F}{d_{\min}}, x\right\}$$

and you will need to find what x is.

Question 4 – Sliding Windows (4 marks)

Suppose that a sender and receiver are connected via a point-to-point link that has 1 Mbps bandwidth and a one-way propagation delay of 4.5 ms. Assume that the sender always has data for transmission and that the size of each data packet is 125 Bytes. Neglect any headers. Also assume that the size of Ack packets is negligible. **Answer each of the following for both go-back-n and selective-repeat sliding window schemes.**

(a) Assuming that the link is error-free, what should be the size of the window (in terms of number of packets) to achieve a throughput of 0.8 Mbps.

(b) What is the minimum number of bits needed to represent the sequence numbers corresponding to the above window size? Recall that an n bit sequence number results in a range of sequence numbers from *0* to 2^n*-1*.

Question 5 – Switchapalooza (4 marks)

SOLVE ONE OF THE FOLLOWING DEPENDING ON YOUR ENROLLMENT. YOU MAY RECEIVE ZERO MARKS IF YOU ATTEMPT THE INCORRECT VERSION.

COMP3331 (UNDERGRADUATE VERSION)

Consider the network in the figure below. Node A and B are connected to each other through Router R. The link between node A and router R has bandwidth T and propagation delay L. The link between the router R and node B has bandwidth 2T and propagation delay L/2.

Consider two cases:

Case 1) The network is circuit-switched: Assume that the circuit setup between A and B has already occurred and that at time t=0, node A begins transmitting a 1 MByte file to node B. As soon as the last bit of the file has been transmitted, node A immediately transmits a 2 MByte file to B. The last bit of the 1MByte file arrives at node B at time t=0.8 seconds. The last bit of the 2MByte arrives at node B at time t=1.8 seconds. Disregard circuit teardown. Hint: A timing diagram may be useful. <u>Show your work in the answer booklet</u>.

What is L (in msec)?

What is T (in Mbps)?

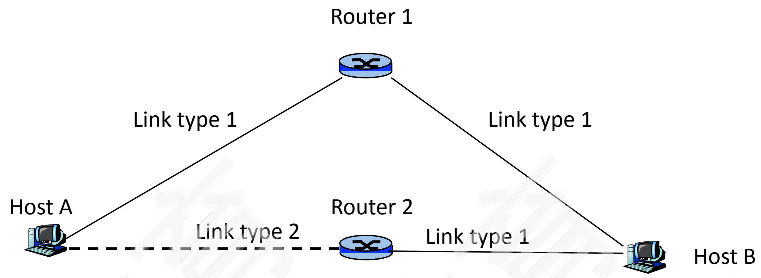
Case 2) The network is packet-switched: Assume that at time t=0, node A begins transmitting a 1 KByte packet to node B. As soon as the last bit of the packet has been transmitted, node A immediately transmits a 2 KByte packet to B. Assume there is no processing delay at the router. The first packet arrives at node B at time t=1.8 milliseconds. The second packet arrives at node B at time t=3.4 milliseconds. Hint: A timing diagram may be useful. Show your work in the answer booklet.

What is L (in msec)?

What is T (in Mbps)?

COMP9331 (POSTGRADUATE VERSION)

Consider the network in the figure below. Host A can choose between two different paths to communicate with host B. Host can choose to send packets via either Router 1 or Router 2 to host B. The communication links are of two different types, as indicated in the figure. The characteristics of these two types of links are:



Link type 1: Each link is of length 2000km, propagation speed is 2 x 10^8 m/s and bandwidth is 100kbps.

Link type 2: Each link is of length 4000km, propagation speed is 2 x 10^8 m/s and bandwidth is 50kbps.

Host A wishes to transmit a message of size 4Kbytes to host B. It breaks this message into 4 packets of equal size. Neglect any packet headers. Remember that routers work on the store-and-forward principle.

Assume that the processing delay and queuing delay in the routers are negligible.

(a) If host A chooses to send the packets via Router 1, draw a timing diagram to show the delay experienced by the packets. By using this timing diagram, determine the time it takes to move the packets from host A to host B, i.e., beginning from the time that host A starts to send the first bit of the first packet till the time that host B receives the last bit of the last packet.

Note: You are required to draw your timing diagram roughly to scale. This will also help you to determine the delay.

(b) Repeat part (a), if host A chooses to send the packets via Router 2

END OF EXAM