FACULTY OF SCIENCE

ACADEMY OF COMPUTER SCIENCE AND SOFTWARE ENGINEERING

MODULE CSC2B10
COMPUTER SCIENCE 2B

CAMPUS AUCKLAND PARK CAMPUS (APK)

MAIN EXAM MEMO

DATE: 2021-10-29 **SESSION:** 14:00 - 16:00

ASSESSOR(S): MR. T MOODLEY
MS. M FOURIE

MODERATOR: DR. J.L. DU TOIT

DURATION: 120 MINUTES **MARKS:** 100

Please read the following instructions carefully:

1. Downloading and Reading time: 14:00 - 14:10
2. Writing time: - 14:10 - 16:10
3. Upload time: 16:10 - 16:40 (No extra time will be awarded)
4. Test support is available on Discord: https://discord.gg/CTBQhsvM
5. Answers may be typed or hand-written and photographed.
6. Where possible, provide answers in the form of a list.

7. Where possible, upload your submission as a single PDF document.
8. Please DO NOT compress (ZIP, RAR, etc.) your submission.
9. Write *cleanly* and *legibly*.
10. You may use a non-programmable calculator to answer the questions.
11. This paper consists of 11 pages.
12. Upload all of your answers before the close of the submission time at 16:40

QUESTION 1

(a) According to the table below, provide an appropriate description for each property under the appropriate column. (1 mark for each description) ***Write down the letter and the correct answer next to it. e.g. (f) Foo*** [3]

Type of network	CAT6	IEEE 802.11ac
Directionality of Medium	Guided	**Unguided**
Material of Medium	**Copper**	Radio Signals
Transmission speed	10Gbps	**1200Mbps**

(b) **Throughput** is defined as "the rate at which bits are transferred between sender and reciever". Using the definition *list* and *describe* the different types of throughput. [02]

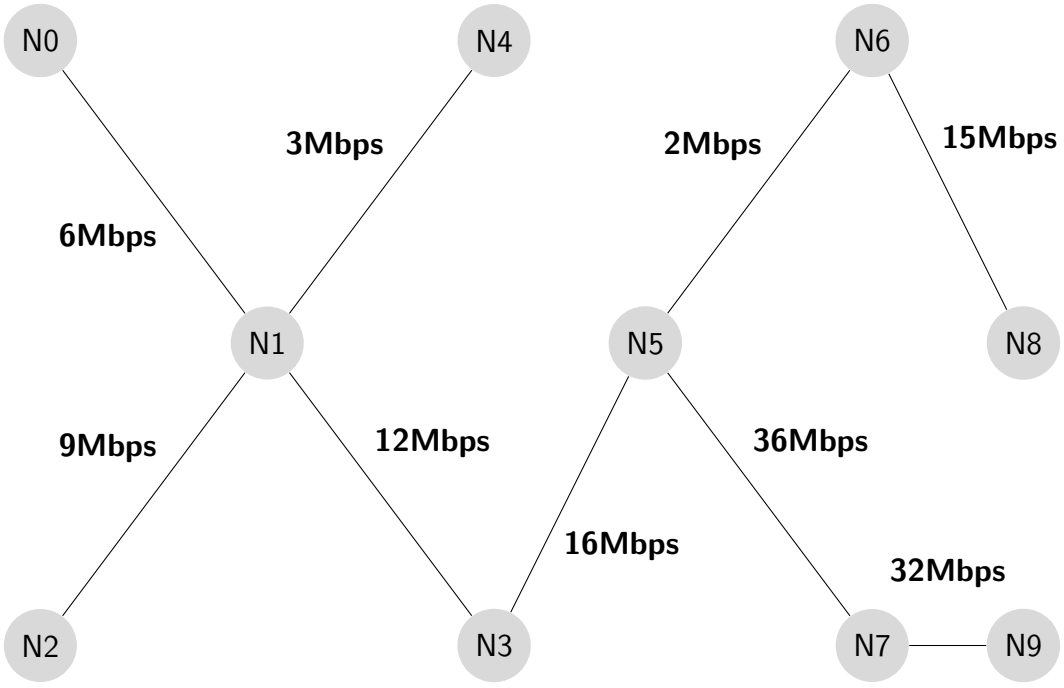
Solution:
- instantaneous: rate at given point in time [1 mark]
- average: rate over longer period of time [1 mark]

Has to have name and description

Total: 5

QUESTION 2

Assume there is a copper network with N0-Nx nodes where, x is the highest number and the transmission rates between these nodes are as follows:



It is also determined that the distances between the nodes are as follows: (Note that all working out must be shown, failure to do this may result in the student receiving zero for the question)

- N0-N1: 20km
- N1-N2: 5km
- N1-N3: 25km
- N1-N4: 15km
- N3-N5: 35km
- N5-N6: 10km
- N5-N7: 60km
- N6-N8: 75km
- N7-N9: 55km

Answer the following questions (Do not round off):

(a) *Determine* the **approximate transmission rate** when communicating between N4 and N9. [1]

Solution:
It will be at 3 Mbps.

(b) Taking this **approximate transmission rate** into account, how *long* (in seconds) will it take to transfer a 180 MegaByte **file** from node N4 to N9? [02]

Solution:
180*8 = 1440 Megabits (1 mark)
800 / 3 = 480 seconds (1 mark) (no if they use their own throughput)
1440/3

(c) If it is determined that the copper installed in this network **propagates** a signal at a speed of 100 000 km/s. *Calculate* the **propagation delay** for communications between N4 to N9. [03]

Solution:
15 + 25 + 35 + 60 + 55 = 190 km (1 marks)
190 / ~~130 000~~ = 0.0019 seconds (2 marks)
100 000

(d) Assuming that there is no nodal processing delay or queueing delay, *calculate* the **total time** taken to transfer a 180 MegaByte file from from N4 to N9? [04]

Solution:
Transmission delay = 1440/3 + 1440/12 + 1440/16 + 1440/36 + 1440/32 = 480 + 120 + 90 + ~~25~~ + 45 = 760 seconds (2 marks)
40
775
Total = ~~760~~ + 0.0019 = ~~760.0019~~ seconds (2 marks) (1 mark if use their own values)
775
775.0019

Total: 10

QUESTION 3

(a) Application protocols define the *message type, message syntax and more*. Both TCP and UDP are protocols within this layer and provide specific services at the application layer, *discuss* these services. [05]

Solution:
TCP service: [max 3 marks]
-connection-oriented: setup required between client and server processes

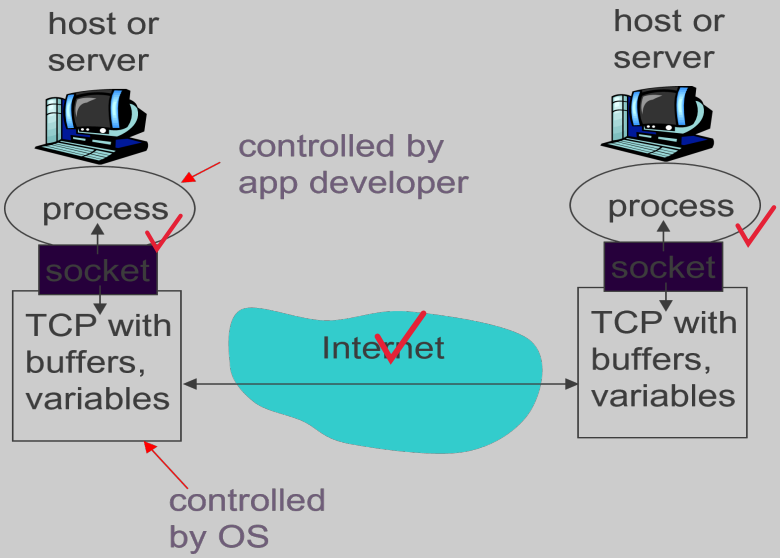
-reliable transport between sending and receiving process
-flow control: sender won't overwhelm receiver
-congestion control: throttle sender when network overloaded
-does not provide: timing, minimum throughput guarantees, security
UDP service: [max 2 marks]
-unreliable data transfer between sending and receiving process
-does not provide: connection setup, reliability, flow control, congestion control, timing, throughput guarantee, or security

Total: 5

QUESTION 4

(a) Within the application layer, processes in different hosts communicate by exchanging messages. **Fully explain** the concept of a **socket and use a diagram** to support your answer. [05]

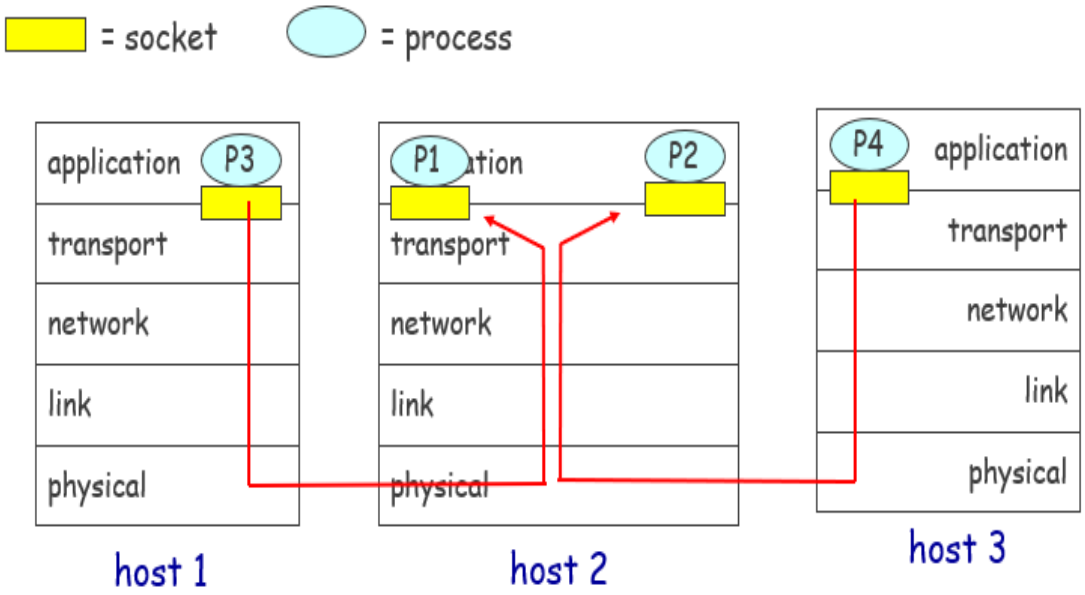
Solution:
-process sends/receives messages to/from its socket
-socket analogous to door 1 mark if they discuss an analogy
-sending process shoves message out door
-sending process relies on transport infrastructure on other side of door which brings message to socket at receiving process



Total: 5

QUESTION 5

(a) Using the diagram below, discuss the manner in which multiplexing and demultiplexing works, be sure to make reference to the diagram in your answer. [06]



Solution:

Socket – used to establish a connection – sits in between the application and transport layer (1 mark)

Process – is basically doing something sits on the socket [1 mark]

Host 2 – demultiplexing – splitting it up - delivering received segments to correct socket [2 marks]

Host 3 and 1 is multiplexing - gathering data from multiple sockets, enveloping data with header (later used for demultiplexing) (2 marks)

(b) We have different reliable data transfer mechanisms to ensure the transfer of data is done reliably. In RDT 2.0, what is the underlying recovery mechanism used to recover from errors? [04]

Solution:

acknowledgements (ACKs): receiver explicitly tells sender that pkt received OK

negative acknowledgements (NAKs): receiver explicitly tells sender that pkt had errors

Total: 10

QUESTION 6

The table below represents the payload of a UDP segment. Calculate the **sum** of the following two 16-bit integers, along with their associated 1s complement **checksum**. ***Note that all working out must be shown, failure to do this may result in the student receiving zero for the question***

Number 1	1	1	1	0	0	1	0	1	0	1	0	0	1	0	1	1
Number 2	1	0	1	1	0	0	1	1	1	1	0	0	1	0	0	1
Sum (1)	1	0	0	1	1	0	0	1	0	0	0	1	0	1	0	0
Wrap around	1	0	0	1	1	0	0	1	0	0	0	1	0	1	0	1
Checksum	0	1	1	0	0	1	1	0	1	1	1	0	1	0	1	0

Solution:

0110 0110 1110 1010

Total: 5

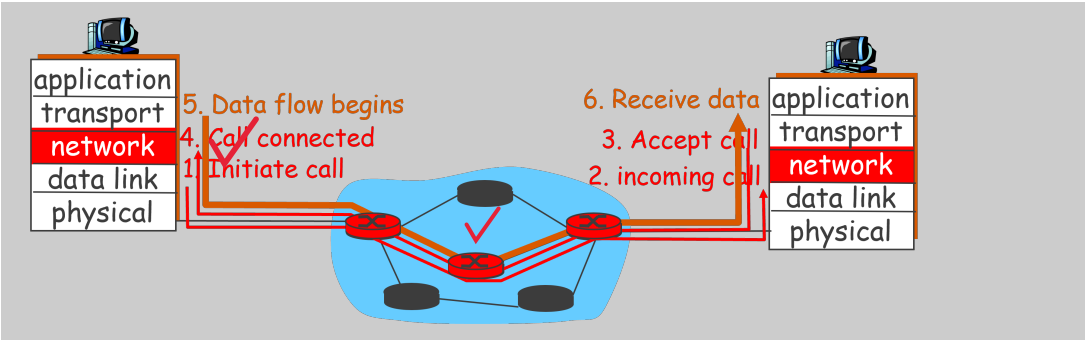
QUESTION 7

(a) In the network layer, we have what is called virtual circuits and datagram networks. *Fully discuss* **virtual circuits** and how they work. *Draw* a diagram to support your answer. [08]

Solution:

(Any valid 6 facts = 6 marks description, 2 marks for diagram)

- Source-to-dest path behaves much like telephone circuit: performance-wise and network actions along source-to-dest path.
- Call setup, teardown for each call before data can flow
- Each packet carries VC identifier (not destination host address)
- Every router on source-dest path maintains "state" for each passing connection
- Link, router resources (bandwidth, buffers) may be allocated to VC (dedicated resources = predictable service)
- A VC consists of: -path from source to destination
- VC numbers, one number for each link along path
- Entries in forwarding tables in routers along path
- Evolved from telephony
- Similar to human conversation: strict timing, reliability requirements, need for guaranteed service
- "dumb" end systems: telephones and complexity inside network



(b) Dynamic Host Configuration Protocol (DHCP) can return more than just the allocated IP address on the subnet. *Explain* what other information you can get from DHCP? [02]

Solution:

Any 2 facts:

Address of first-hop router for client

Name and IP address of DNS sever

Network mask (indicating network versus host portion of address)

Total: 10

QUESTION 8

Given the following **IP address** and **CIDR**, answer the questions that follow (Note that all working out must be shown, failure to do this may result in the student receiving zero for the question):

5.111.45.213/30

(a) Provide this address in **binary** notation. [02]

Solution:

00000101 01101111 00101101 11010101 no working out = no marks

(b) How many hosts can this network **accommodate**? [02]

Solution:

32 - 30 = 2

2^2 = 4-2=2

(c) Assuming classful addressing was used, what **class** does this address belong to? [02]

Solution:

Class A.

(d) Calculate the **network address** of this block in dotted decimal notation. [02]

Solution:
11010**00** = 212
5.111.45.212

must show working out from binary to decimal
2 marks for calculating the 212

if no working out then 0

(e) Calculate the **broadcast address** of this block in dotted decimal notation. [02]

Solution:
11010**11** = 215
5.111.45.215

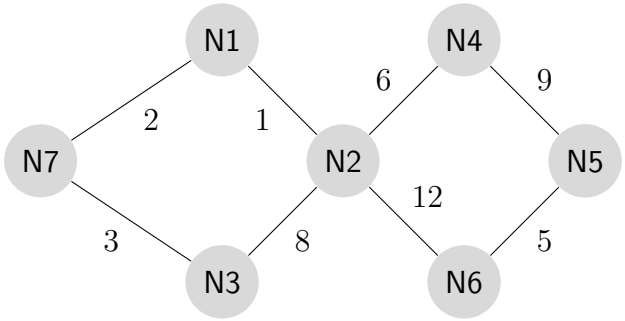
must show working out from binary to decimal
2 marks for calculating the 215

Marks awarded based on discretion, motivations are given

Total: 10

QUESTION 9

Given the below network **routing graph** (with costs), answer the following questions that follow (Note that all working out must be shown, failure to do this may result in the student receiving zero for the question):



(a) What is the path with the **least cost** when communicating between N6 and N7. Is this the **only** cost effective path? [02]

Solution:
N6-N2-N1-N7 = 15 (1 mark)
Yes (1 mark)

(b) Given the local datagram **forwarding table** for node N2 below and the destination address is 125.98.47.25, which link will this packet be forwarded to? Please ensure to show all your calculations. [03]

Destination Address range	Output Link Interface
01111101 01100010 00101111 01011***	N4
01111101 01100010 00101111 0001****	N5
01111101 01100010 00101111 000*****	N8
Otherwise	N6

Solution:
IP in binary: 01111101 01100010 00101111 ~~0001100~~ (2marks)
00011001
Link N5 (1 mark)

only look at the last 8 bits and give them 2 marks assuming they have shown the working out

Total: 5

QUESTION 10

(a) Within the context of the **data link layer**, *describe* how the "taking turns" MAC protocol works when the polling approach is used and *discuss* concerns one might have with this approach. [05]

Solution:

2 marks for how it works and 3 marks for concerns

- Master node "invites" slave nodes to transmit in turn
- Typically used with "dumb" slave devices
- Concerns:
- Polling overhead
- Latency
- Single point of failure (master)

(b) Discuss what **ARP** is and **describe** its basic message types. [05]

Solution:

- ARP - Address Resolution Protocol, a very simple protocol, consists of merely four basic message types:
- An ARP Request. Computer A asks the network, "Who has this IP address?"
- An ARP Reply. Computer B tells Computer A, "I have that IP. My MAC address is [whatever it is]."
- A Reverse ARP Request (RARP). Same concept as ARP Request, but Computer A asks, "Who has this MAC address?"
- A RARP Reply. Computer B tells Computer A, "I have that MAC. My IP address is [whatever it is]"

Total: 10

QUESTION 11

(a) You have been approached by the University to create an **Android** mobile application which will enable the Protection Services Department to respond to student alerts and monitor campus more effectively. **Describe three** security best-practice principles that would be your main focus in the creation of the app. Give a **reason** why security is an important consideration for such an app. [04]

Solution:
(3 marks for the principles, 1 mark for the reason)

- Encrypt your data
- Detect insecure devices
- Authenticate users and keys using bio metrics
- Communicate securely (SSL)
- Testing
- Audit third party libraries
- REASON - any valid reason: Data sensitivity, Confidentiality, integrity, privacy etc.

(b) **Briefly discuss** how the **ipconfig** command works. [01]

Solution:

- Displays all current TCP/IP network configuration values and refreshes Dynamic Host Configuration Protocol (DHCP) and Domain Name System (DNS) settings.

Total: 5

QUESTION 12

Provide Java source code for a **UDP Server** bound to port 2021 that that receives a packet and sends a message back. (Note screenshots are not allowed and will be given zero.)

Solution:

Ignore letters

```
1  import java.io.*;
2  import java.net.*;
3  class UDPServer {
4    public static void main(String args[])
5    {
6      try
7      {
8        DatagramSocket serverSocket = new DatagramSocket(2021);
9        byte[] receiveData = new byte[1024];
10       byte[] sendData = new byte[1024];
11       while(true)
12       {
13         DatagramPacket receivePacket =
14             new DatagramPacket(receiveData, receiveData.length);
```

```
15          serverSocket.receive(receivePacket);
16          String sentence = new String( receivePacket.getData());
17          System.out.println("RECEIVED: " + sentence);
18          InetAddress IPAddress = receivePacket.getAddress();
19          int port = receivePacket.getPort();
20          String capitalizedSentence = sentence.toUpperCase();
21          sendData = capitalizedSentence.getBytes();
22          DatagramPacket sendPacket =
23              new DatagramPacket(sendData, sendData.length, IPAddress
                    , port);
24          serverSocket.send(sendPacket);
25          }
26       }
27       catch(IOException io)
28       {
29         System.err.println(io.getMessage());
30       }
31    }
32 }
```

Total: 10

QUESTION 13

The code below illustrates a **TCP client** that receives a binary file using the getfile() method. Fill in the missing code for sections A to I. Clearly label your answers.

```
1  import java.io.*;
2  import java.net.*;
3
4  class TCPBinGet
5  {
6    public void getfile(String address, int port, String filename, int
         length)
7    {
8      File newFile = new File(filename);
9      FileOutputStream fos = null;
10     Socket fileSocket = null;
11     try
12     {
13       fileSocket = __( A (1 marks) )__;
14       InputStream is = __( B (1 marks) )__;
15       fos = new FileOutputStream(newFile);
16       byte[] buffer = new byte[512];
17       int n = 0;
18       int totalBytes = __( C (1 marks) )__;
19       while (totalBytes != length)
20       {
21         __( D (2 marks) )__;
22         __( E (1 marks) )__;
23         fos.flush();
24         __( F (1 marks) )__;
25       }
26     }
27     catch (FileNotFoundException ex) { ex.printStackTrace(); }
```

```
28      catch (IOException ex) { ex.printStackTrace(); }
29      finally
30      {
31        if(__( G (1 marks)) )__
32        {
33          try { __( H (1 marks) )__; }
34          catch (IOException e) { e.printStackTrace(); }
35        }
36        if (fos != null)
37        {
38          try {__( I (1 marks) )__ ; }
39          catch (IOException e) { e.printStackTrace(); }
40        }
41      }
42    }
43  }
```

Solution:

Question	Code	Mark
A	new Socket(address, port)	1
B	fileSocket.getInputStream();	1
C	0	1
D	n = is.read(buffer, 0, buffer.length);	2
E	fos.write(buffer, 0, n);	1
F	totalBytes += n;	1
G	fileSocket!=null	1
H	fileSocket.close();	1
I	fos.close();	1

dis.read...

Total: 10

The End!