NATIONAL UNIVERSITY OF SINGAPORE

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

ONLINE EXAMINATION

Matriculation No.:	A0224725H
Module Code:	EE 4204
Number of pages in this PDF file (including this cover page and Declaration Form): i.e. 2+no. of answer pages	7

INSTRUCTIONS TO CANDIDATES

1. Follow the instructions for online examination and invigilation.

2. Write your answers on A4 size paper with black or dark blue ink.

3. Write the question number at the top left corner of each page. Start the answer to each question on a new page. Indicate the part, e.g. "(a)", on the left margin.

4. At the end of the exam:
   a) scan or take photographs of your answers (make sure your writing and/or drawings can be seen clearly);
   b) enter your matriculation number, module code and the total number of pages (including the cover and declaration pages, i.e. 2+number of answer pages) on the cover page;
   c) merge the completed cover page, signed declaration form and your answers into a single PDF file named **<matric_no>-<module code>.pdf** (e.g. **A1234567R-EExxxx.pdf**)
   d) open the PDF file to ensure that it has been generated without error and the contents are correct;
   e) upload your PDF file into the stated LumiNUS exam submission folder within the stipulated deadline. Late submissions will not be accepted.

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Question	Mark	Remarks
TOTAL		

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Exam Declaration Form

Please read sections A, B and C below. Sign and submit this declaration form together with your answers.

A. Academic, Professional and Personal Integrity

1. *The University is committed to nurturing an environment conducive for the exchange of ideas, advancement of knowledge and intellectual development. Academic honesty and integrity are essential conditions for the pursuit and acquisition of knowledge, and the University expects each student to maintain and uphold the highest standards of integrity and academic honesty at all times.*

2. *The University takes a strict view of cheating in any form, deceptive fabrication, plagiarism and violation of intellectual property and copyright laws. Any student who is found to have engaged in such misconduct will be subject to disciplinary action by the University.*

3. *It is important to note that all students share the responsibility of protecting the academic standards and reputation of the University. This responsibility can extend beyond each student's own conduct, and can include reporting incidents of suspected academic dishonesty through the appropriate channels. Students who have reasonable grounds to suspect academic dishonesty should raise their concerns directly to the relevant Head of Department, Dean of Faculty, Registrar, Vice Provost or Provost.*

B. I have read and understood the rules of the assessments stated below:

a. *Students should attempt the assessments on their own. There should be no discussion or communication, via face to face or communication devices, with any other person during the assessment.*

b. *Students should not reproduce any assessment materials, e.g. by photography, videography, screenshots, copying down of questions, etc. Posting on public forums, e.g. social media and websites, is prohibited.*

C. I understand that by breaching any of the rules above, I would have committed offences under clause 3(I) of the NUS Statute 6, Discipline with Respect to Students, which is punishable with disciplinary action under clause 10 or clause 11 of the said statute.

3) Any student who is alleged to have committed or attempted to commit, or caused or attempted to cause any other person to commit any of the following offences, may be subject to disciplinary proceedings:
(I) plagiarism, giving or receiving unauthorised assistance in academic work, or other forms of academic dishonesty.

I have read and will abide by the NUS Code of Student Conduct (in particular, (A) Academic, Professional and Personal Integrity), B and C when attempting this assessment.

Signature: LUO ZIJIAN Date: 4th May, 2021

Matric. No.: A0224725H

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A0224725H

Q1

(a) (i) A —100us→ S —100us→ B, AS: packet transmission time = $\frac{10000}{100}$ = 100 us
100 Mbps, 10 Mbps
SB: packet transmission time = $\frac{10000}{10}$ = 1000 us

so the time when the second packet is completely transmitted at swith S.
means that second packet needs to ~~transmitted~~ traverses 1 links.
And it need to be transmitted at S.
t = 2×100 + 2×1000 + 100 = 2300 us

(ii) As for the total message transfer time, means A receive two Ack from B
T = 2×100 + 2×1000 + 100×2 + ~~200~~ 100×2 = 2600 us

(iii) As for throughput, throughput = $\frac{\text{Message size}}{\text{Message transfer time}}$ = $\frac{20000 \text{ bit}}{2600 \text{ us}}$ = 7.69 Mbps

Q1 (b)
```
      11100011
   ---------
111 | 10101000
      111
      ---
       100
       111
       ---
        111
        111
        ---
         100
         111
         ---
          10
          111
          ---
           1
```
Dividing 10101010 by 111, get a non-zero remainder
Therefore, the receiver deterts the error.

CRC bit is 10101001

Q1 (c) SONET OC-12 frame: frame size = 12×810 = 9720 bytes
frame time = 125 us
data rate = $\frac{9720 \text{ bytes}}{125 \text{ us}}$ = 622.08 Mbps

Q1 (d) (i) 1 Gbps = 10^9 bit/s = 1 G bit/s
Total size = 50 GB = 400 G bit
t = $\frac{\text{Total size}}{\text{Bandwidth}}$ = 400 s
so the ~~total~~ minimum possible transfer time in the ideal case is 400s

(ii)
① Packet lose during the download process
② Anyone may share with Sam in his home network

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Q2

(a) i) $T_{transfer} = \frac{210 \times 1000 \times 8}{100 \times 10^6} = 1.68 \times 10^{-2}\ s = 16800\ us$

~~$T_{propogation} = 100 \times 5 = 500\ us$~~

So the time taken to transfer the message is 16800 us

(ii) $T_{propogation} = 100 \times 5 = 500\ us$

$T_f = \frac{1000 \times 8}{100 \times 10^6} = 80\ us \qquad a = \frac{T_p}{T_f} = 6.25$

$W \geq 1 + 2a = 13.5$,

in this range, the transfer time is minimum

(iii) each frame can be sent continuously.

$T_{total} = T_{transfer} + T_p = 16800 + 500 = 17300\ us$

Q2 (b) In fourth collision, sixth collision, seventh collision

~~Pr(A win) =~~ Host A slot : [0, 15]

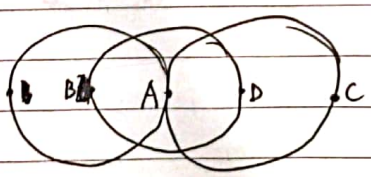
Host B slot : [0, 31]

Pr(A wins) =

Q2 (c)

Q2 (d). A → B

D → C



These two transfer can take place simultaneously.

Because A's transmission to B will not interfere with D's ability to C

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Q3

(a)

Node A	
Destination	Next hop
B	C
C	C
D	C
E	C
F	C

Node B	
Destination	Next hop
A	E
C	E
D	E
E	E
F	E

Node C	
Destination	Next hop
A	A
B	E
D	E
E	E
F	E

Node D	
Destination	Next hop
A	E
B	E
C	E
E	E
F	E

Node E	
Destination	Next hop
A	C
B	B
C	C
D	D
F	C

Q3 (b)

(i)	TRUE
(ii)	TRUE
(iii)	TRUE
(iv)	FALSE
(v)	FALSE

Q3 (c) 192.168.100.192/28 => 11000000.10101000.01100100.11000000

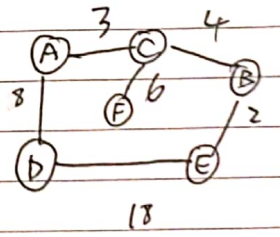
So the broadcast Ipv4 : 192.168.100.207

sub net mask : 255.255.255.240

Q3 (d)

Node B	
Destination	Next hop
A	C
C	C
D	C
E	E
F	C

Node E	
Destination	Next hop
A	B
B	B
C	B
D	B
F	B



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Q3

Date No.

(e)

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(5)

Q4

Date No

(a) After analysis, these four TCP flows all needs to $R_1 \leftrightarrows R_2$ Owing to same round trip time, the approxiamate throughput of each is $\frac{C_1}{4}$

Q4 (b). (i) max-min fair allocation: $\begin{cases} R_1 \to R_2 : \frac{1}{2}C \text{ (flow 1)}, \frac{1}{2}C \text{ (flow 2)} \\ R_2 \to R_3 : \frac{1}{2}C \text{ (flow 1)}, \frac{1}{2}C \text{ (flow 3)} \end{cases}$

total throughput : $\frac{3}{2}C$

(ii) maximized total throughput: $\begin{cases} R_1 \to R_2 : 0 \text{ (flow 1)}, C \text{ (flow 2)} \\ R_2 \to R_3 : 0 \text{ (flow 1)}, C \text{ (flow 3)} \end{cases}$

total throughput : $C + C = 2C$

(iii) we set x in $R_1 \to R_2$ (flow 1), so x in $R_2 \to R_3$ (flow 1)

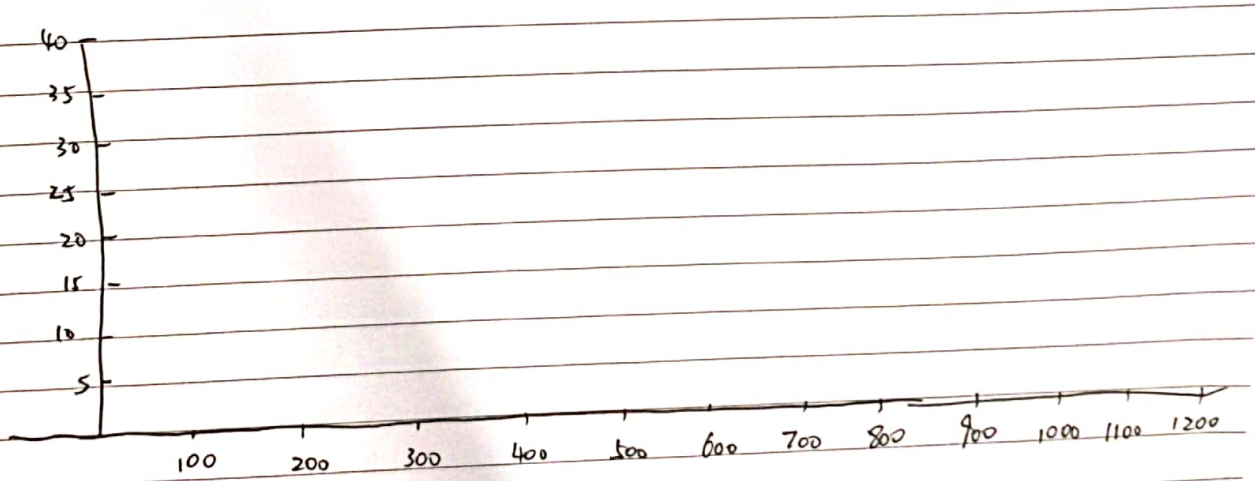
In order to be fair $2X = C - X$ $X = \frac{1}{3}C$

allocation $\begin{cases} R_1 \to R_2 : \frac{1}{3}C \text{ (flow 1)}, \frac{2}{3}C \text{ (flow 2)} \\ R_2 \to R_3 : \frac{1}{3}C \text{ (flow 1)}, \frac{2}{3}C \text{ (flow 3)} \end{cases}$

Total throughput $= \frac{1}{3}C + \frac{2}{3}C + \frac{2}{3}C = \frac{5}{3}C$

(c) (i) fast recovery : to improve throughput.

(ii)



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