

**Xi'an Jiaotong-Liverpool University**

**西交利物浦大学**

PAPER CODE	EXAMINER	DEPARTMENT	TEL
CAN201		CAN	

**1st SEMESTER 2023/24 FINAL EXAMINATION**

**Undergraduate – Year 3**

**INTRODUCTION TO NETWORKING**

**TIME ALLOWED: 2 Hours**

---

**INSTRUCTIONS TO CANDIDATES**

1. This is a closed-book examination, which is to be written without books or notes.
2. Total marks available are 100.
3. There are 5 questions. Answer all questions.
4. Answer should be written in the answer booklet(s) provided.
5. Only English solutions are accepted.
6. All materials must be returned to the exam supervisor upon completion of the exam. Failure to do so will be deemed academic misconduct and will be dealt with accordingly.

16

Question 1 (20 points)

带宽是什么?

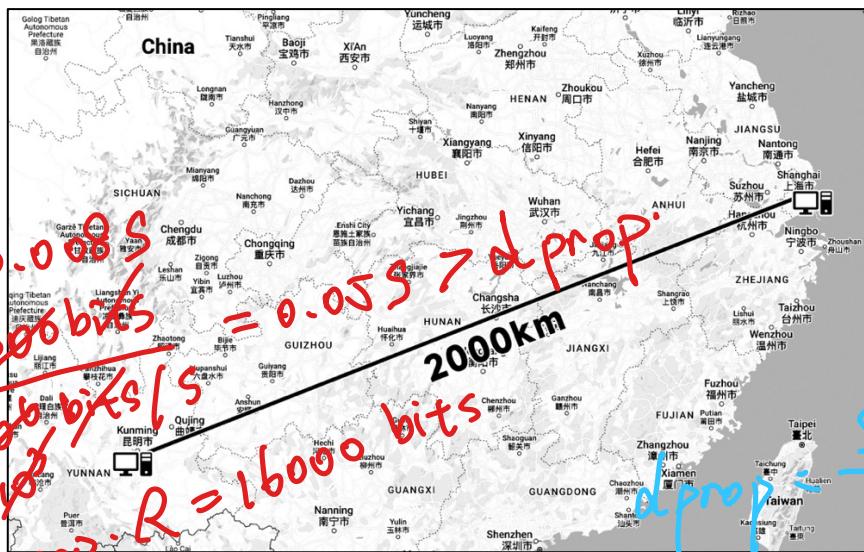


Fig 1. Locations of two hosts.

Suppose two hosts, located in Kunming and Shanghai, are separated by 2,000 kilometers, and are connected by a direct link of  $R = 2 \text{ Mbytes/s}$ . Suppose the propagation speed over the link is  $2.5 \cdot 10^8 \text{ meters/sec}$ . (In this question,  $1\text{Mb}=1,000\text{Kb}=1,000,000\text{b}$ )

1. Calculate the bandwidth-delay product:  $R \cdot d_{prop}$ . (5 points)
2. Consider sending a file of 100,000 bits from the host in Kunming to the host in Shanghai. Suppose the file is sent continuously as one large image. What is the maximum number of bits that will be in the link at any given time? (5 points)
3. Provide a definition of the "bandwidth-delay product". (5 points)
4. What is the width (in meters) of a bit in the link? (2 points)
5. Derive a general expression for the width of a bit in terms of the propagation speed  $s$ , the transmission rate  $R$ , and the length of the link  $m$ . (3 points)

 $S/R$ 

~~the product of bandwidth with one-way propagation~~  
~~maximum number of bits~~  
~~can be transfer at any time~~  
 $\Rightarrow 0.008 \text{ bit/m}$

$1 \text{ bit} / 12.5 \text{ m}$

Question 2 (20 points)

The Hyper-Text Transfer Protocol (HTTP), one of the mostly used application-layer protocol, is at the heart of the Web.

1. Decide whether the following statements related to HTTP are correct (True / False):
  - a) A user requests a Web page that consists of some text and 4 images. For this page, the client will send one request message and receive 5 response messages. (2 points)
  - b) Two distinct Web pages (for example, <https://www.suda.edu.cn/research.html> and <https://sat.xjtu.edu.cn/staff.html>) can be sent over the same persistent connection. (2 points)
  - c) With non-persistent connections between browser and origin server, it is possible for a single TCP segment to carry two distinct HTTP request messages. (2 points)
  - d) HTTP response messages never have an empty message body. (2 points)
  - e) The HTTP protocol can only be used for webpages. (2 points)

2. The text below shows the reply sent from the server in response to an HTTP GET message. Answer the following questions, indicating where in the message below you find the answer.

```
HTTP/1.1 200 OK<br><lf>Date: Tue, 07 Mar 2023  
12:39:45GMT+8<cr><lf>Server: Apache/4.0.52<cr><lf>Last-Modified: Sat,  
10 Dec 2022 18:27:46 GMT+8<cr><lf>Accept-Ranges: bytes<cr><lf>Content-  
Length: 3874<cr><lf>Keep-Alive: timeout=max=100<cr><lf>Connection:  
Keep-Alive<br>Content-Type: text/html; charset=utf-  
8<br><cr><lf><cr><lf><!doctype html public "-//w3c//dtd html 4.0  
transitional//en"><lf><html><lf><head><lf> <meta http-equiv="Content-  
Type" content="text/html; charset=utf-8"><lf> <meta name="GENERATOR"  
content="Mozilla/4.79 [en] (Windows NT 5.0; U) Netscape]"><lf>  
<title>Unleash Yourselves and Dare to be Rationally  
Unconventional</title><lf></head><lf><body><H1>Unleash Yourselves and  
Dare to be Rationally Unconventional</H1><p>Last Modify Date: 1 Dec  
2022</p> ...<much more document text following here (not shown)>
```

1.5

- a) Was the server able to successfully find the document or not? What time was the document reply provided? (2 points) *Yes*
- b) When was the document last modified? (2 points) *Tue, 07. Mar 2023*
- c) How many bytes are there in the document being returned? (2 points) *3874*
- d) What are the first 9 bytes of the document being returned? (2 points) *<!doctype*
- e) Did the server agree to a persistent connection? (2 points) *No*

*Yes**<!doctype*

### Question 3 (20 points)

Complete the following table using Dijkstra's algorithm. Compute the shortest path from node A to all network nodes shown in Fig. 2. Note: Possible ties are broken in favor of the leftmost column.

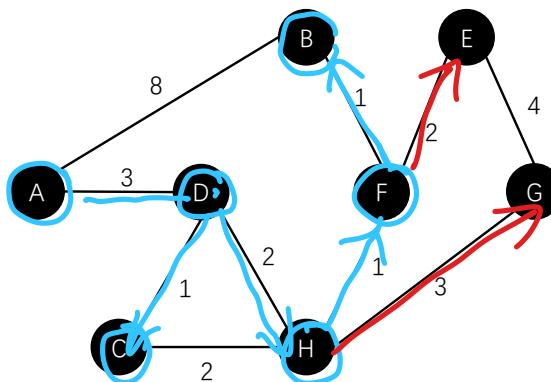


Fig. 2

Step	$N'$	$D(B), p(B)$	$D(C), p(C)$	$D(D), p(D)$	$D(E), p(E)$	$D(F), p(F)$	$D(G), p(G)$	$D(H), p(H)$
0	A	8, A	$\infty$	3, A	$\infty$	$\infty$	$\infty$	$\infty$
1	AD	8, A	4, D	Done	$\infty$	$\infty$	$\infty$	5, D
2	ADC	8, A	Done		$\infty$	$\infty$	$\infty$	5, D
3	ADCH	8, A			$\infty$	6, H	8, H	Done
4	ADCHF	7, F			8, F	Done	8, H	
5	ADCHFB	Done			8, F		8, H	
6	ADCHFBE				Done		8, H	
7	ADCHFBEG							

**Question 4 (20 points)**

Consider the following Fig 3, where several subnets are interconnected.

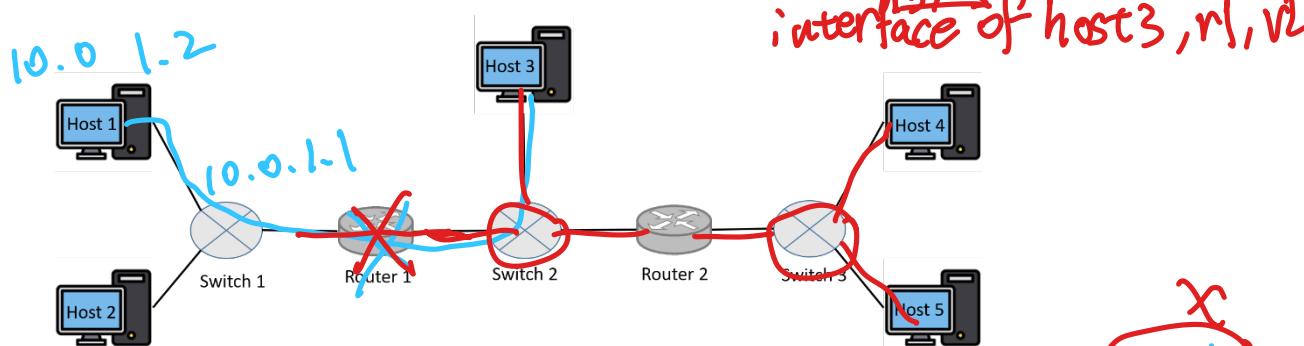


Fig. 3

1. Please list all the subnets in this network? Hint: list them in terms of network interfaces. (9 points) the interface of h<sub>1</sub>, s<sub>1</sub>, h<sub>2</sub>, r<sub>1</sub>, r<sub>2</sub>, s<sub>3</sub>, h<sub>4</sub>, h<sub>5</sub>
2. If Router 1 is removed, and Switch 1 and Switch 2 are linked directly, then there are how many subnets left? Explain what they are. (5 points) 2, (h<sub>1</sub>, h<sub>2</sub>, s<sub>1</sub>, s<sub>2</sub>, h<sub>3</sub>)
3. Assuming the interface of Host 1 has an IP address 10.0.1.2, and the adapter for that interface has a MAC address aa-aa-aa-aa-aa-aa; the interface of Router 1 lined with Switch 1 has an IP address 10.0.1.1, and the adapter for that interface has a MAC address 11-11-11-11-11-11. Now, consider sending an IP datagram from Host 1 to Host 3. Suppose Host 1 has an empty ARP table, while Router 1 has the up-to-date ARP table and routing table respectively.

Describe all the steps to succeed in sending the IP datagram. (6 points)

① check h<sub>1</sub>, h<sub>3</sub> if in the same subnet, as not? so h<sub>1</sub> send the datagram to default network connection & | 10.0.1.1

② As empty ARP Table, h<sub>1</sub> not know R<sub>1</sub> Mac address, so it's request ARP for querying Mac address of 10.0.1.1

Question 5 (20 points)

Alice wants to communicate with Bob. Assuming they are using public-key cryptography (e.g., RSA) directly and so Alice has her public key  $K_A^+$  and private key  $K_A^-$  while Bob has his public key  $K_B^+$  and private key  $K_B^-$ . Also, we assume that Alice and Bob have got each other's public key through a certificate authority (CA). With the above, Alice now would like to send a message M to Bob.

⑤ Router 1 decapitates IP datagram and check its routing table.

forward to ~~host S2, S2 → h3,~~

- If Alice would like to ensure the confidentiality of this message transmission. That means only Bob can decrypt the cipher-text of M. Please draw a diagram to show how Alice would encrypt the message M. (6 points)



- If Alice would like to ensure the integrity of this message transmission. That means Bob can verify that M was sent by Alice and M was not altered during transmission. Please draw a diagram to show how Alice would transmit the message M. (Hint: you can use H(x) to express the hash function). (6 points)

- Now if Alice and Bob want to share a secret key  $K_S$  and will use the secret key for encrypting the message. Please use a diagram to show how Alice would use the public-key cryptography to transmit  $K_S$  to Bob whereby both confidentiality and integrity should be guaranteed. (8 points)

