CS3205 – Introduction to Computer Networks
End Semester Examination - Jan-May 2020
Total marks: 100, Time: 24 hour take home test.
02/January/2021 10 AM to 03/January/2021 10 AM

  i. Please read the question paper carefully before you start to answer the questions.
 ii. It is expected most of the questions can be answered in one or two sentences.
iii. Question paper has 4 parts. All questions are to be answered.

PART - A. Total 20 marks.

1. State True or False, and Justify in a sentence. (2 marks)

   (a) HTTP is a stateful protocol.
   (b) Open Shortest Path Firt (OSPF) uses UDP for information exchange to enable faster convergence.

2. What is the difference between routing and forwarding? (2 marks)

3. What is HOL blocking? Does it occur in input ports or output ports? (2 marks)

4. Can the Source IP address of a valid IP packet be 0.0.0.0? Justify the condition/protocol scenario. (2 marks)

5. A IP packet contains an UDP segment of 32 bytes. The segment contents is xF0 repeated 32 times. i.e., 0xF0F0 0xF0F0 0xF0F0 0xF0F0 four times. What is the checksum value in the UDP header? (2 marks)

6. The Ether type value in the Ethernet Header for the networking protocols - IPv4, Virtual LAN, IPv6 and ARP are —-, —-, —-, and ——. (2 marks)

7. Indicate the main application layer protocol(s) used by the applications - WhatsApp, Thunderbird, Google Chrome and Git. (2 Marks)

8. Bob has to host his email server within his office. His colleagues would need to access the server while they are within the office as well as they are outside.

   (a) Can Bob accomplish enabling email access both while inside and from outside his office? Why/Whynot?? (1 mark)
   (b) What protocols (unsecured/secured, with their corresponding port numbers) would Bob need to support for hosting his email server? (State function of the protocol(s) in brief. max two sentences.) (3 marks)

9. List the delay components that result due to the architecture/design of a networking device. For each delay component indicate if it is a fixed or varying delay. In a sentence justify reason for the delay behavior. (2 marks.)

PART - B. Each question 4 Marks - Total 24 marks.

1. Alice wishes to transfer a file of size 120,000 Bytes between two systems. Let the size of data transferred in every segment is 200 Bytes, If the data is transferred using UDP and IP what will be the overhead in terms of bytes (UDP and IP together) and % per IP packet? If the data is transferred using TCP and IP what will be the overhead in terms of bytes (TCP and IP together) and % per IP packet? (3 decimal precision required.).

2. What is Class based and Class-less IP addressing? Give necessary example values for all the different types of Classes and for Class-less IP addresses. (NOTE: Your roll number be part of the IP address, i.e one of the byte)

3. (a) Suppose N packets arrive simultaneously to a link at which no packets are currently being transmitted or queued. Each packet is of length L and the link has transmission rate R. What is the average queuing delay for the N packets?

   (b) Now suppose that N such packets arrive to the link every LN/R seconds. What is the average queuing delay of a packet?

4. Suppose four active nodes—nodes A, B, C and D—are competing for access to a channel using slotted ALOHA. Assume each node has an infinite number of packets to send. Each node attempts to transmit in each slot with probability p. The 1st slot is numbered slot 1, the 2nd slot is numbered slot 2, and so on.

   (a) What is the probability that node A succeeds for the first time in slot 5?

   (b) What is the probability that some node (either A, B, C or D) succeeds in slot 4?

   (c) What is the probability that the first success occurs in slot 3?

   (d) What is the efficiency of this four-node system?

5. With suitable example(s) show/discuss/highlight

   (a) GBN is better compared to SR and SR being better compared to GBN.

   (b) Congestion control and Flow control in applications are different with different purposes (applied w.r.to TCP)

6. Assume there exists a dedicated 1Gbps fibre link between IIT-Madras and IIT-Delhi, and the distance between the campus is roughly 2200 Km. How big should the window size be for the channel utilization to be greater than 92% and 98%? Suppose we transmit packets of size a) 1500 bytes and b) 9000 bytes - which includes all headers in both cases. Assume Fibre link supports travel speed of 2.5 $\times 10^8$ m/s. Provide in detail the calculations.

PART - C. Each Question 5 Marks - Total 20 marks.

1. (a) Which layer restricts the size of information carried across a network and What is it called? (2 *0.5 marks)

   (b) If suppose the application wishes to send a large data say 100KBytes, in what/how many possible ways can the layer(s) perform actions to meet the restriction? (2 * 1 marks)

   (c) How can one figure out the layer(s) involved in the restriction based on a wire shark capture? (2 * 1 marks)

2. Identifiers are required to ensure data flows, i.e. source or destination identifier.

   (a) What constitutes the identifiers at the different layers in TCP/IP Networking Model (assume IPv4). Give an example for each of the identifier? (1 mark)

   (b) What is the address space for each of the identifiers? (2 Marks)

   (c) What identifier(s) vary if the Network is an IPv6 network. If so what is the variation in the address space? (2 Marks)

3. Four packets captured via wireshark are analyzed. They are given in Figures 1(a) to 1(d).

   (a) What protocol message exchanges are shown in the figures? (1 Mark)

```
1c 5f 2b 2d 16 00 64 5d   86 7c 78 74 08 06 00 01   ·_+···d] ·|xt····
08 00 06 04 00 01 64 5d   86 7c 78 74 c0 a8 01 04   ······d] ·|xt····
1c 5f 2b 2d 16 00 c0 a8   01 01                     ·_+····· ··
```

(a) WireSharkCapture - PACKET 1.

```
64 5d 86 7c 78 74 1c 5f   2b 2d 16 00 08 06 00 01   d]·|xt·_ +·······
08 00 06 04 00 02 1c 5f   2b 2d 16 00 c0 a8 01 01   ········_ +·······
64 5d 86 7c 78 74 c0 a8   01 04                     d]·|xt·· ··
```

(b) WireSharkCapture - PACKET 2.

```
ff ff ff ff ff ff 64 5d   86 7c 78 74 08 06 00 01   ······d] ·|xt····
08 00 06 04 00 01 64 5d   86 7c 78 74 c0 a8 01 04   ······d] ·|xt····
00 00 00 00 00 00 c0 a8   01 05                     ········ ··
```

(c) WireSharkCapture - PACKET 3.

```
64 5d 86 7c 78 74 88 b4   a6 28 76 16 08 06 00 01   d]·|xt·· ·(v·····
08 00 06 04 00 02 88 b4   a6 28 76 16 c0 a8 01 05   ········ ·(v·····
64 5d 86 7c 78 74 c0 a8   01 04                     d]·|xt·· ··
```

(d) WireSharkCapture - PACKET 4.

Figure 1: WireShark Capture - PACKETS 1 - 4

   (b) **For each of the Packet, list the details/information that you can gather from the figures - source, destination details, protocol message type, requested and received information? (1 mark each)**

4. **Identity the protocol associated with the Wireshark capture given in Figure 2 below. List all the different packet components and explain what the packet intends to achieve.**

```
1c 5f 2b 2d 16 00 64 5d   86 7c 78 74 08 00 45 00   ·_+···d] ·|xt··E·
00 3e b7 a6 00 00 80 11   00 00 c0 a8 01 04 da f8   ·>······ ········
70 31 de ef 00 35 00 2a   0d 12 00 04 01 00 00 01   p1···5·* ········
00 00 00 00 00 00 03 77   77 77 08 73 74 61 6e 66   ·······w ww·stanf
6f 72 64 03 65 64 75 00   00 01 00 01               ord·edu· ····
```

Figure 2: WireShark Capture - PACKET 5

PART - D. Each Question 6 Marks - Total 36 marks.

1. **Medium has to be shared for multiple entities to interact.**

   (a) **Name the medium access method that enables all entities to utilize the full medium (spectrum) for data exchange at a given time instance. What is the limitation if any (1 mark)**

(b) **Assuming yourself and a set of 7 other students use the method to exchange data, how can you accomplish exchange of data using this method for each one of you?(1 Mark)**

(c) **Let F_0 denote yourself, and F_1, F_2, ..., F_7 denote your seven friends. Assume IF your roll number is CS17B201, then the one byte data to transmitted by the person F_i will be mod$((201+(i*100)),255)$. The data to be transmitted then will be: F_0 is 201(0xC9), F_1 is 46(0x2E), F_2 is 146(0x92), F_3 is 246(0xF6), F_4 is 91(0x5B), F_5 is 191(0xBF), F_6 is 36(0x24) and F_7 is 136(0x8). Each bit of the data is transmitted at given time instant, i.e. first bit at instance 1, second bit at instance 2, and eighth bit at instance 8.**

Determine the data for a set comprising yourself and your seven friends? (Please use your roll number adopting the example explained. IF not no credits.)

   i. **Assume F_0, F_2, F_5, F_7 are the ones to transmit. What will be medium state/data at instance 4 and 7? Show detailed steps. (2 marks)**

   ii. **How can F_3 receive F_2's data from the medium at instance 4, and F_4 receive F_0's data from the medium at instance 7? (2 marks)**

2. **Errors can occur during data exchange. Hence, it must be detected and possibly corrected.**

   (a) **At which layer (first) when data is received at a system it is possible to detect and correct errors. What other services are provided by this layer (2 marks)**

   (b) **Nine bits of data, a set of 3x3 bits are transmitted with an ability to detect and recover errors. The received 4x4 data is 1100, 1110, 1111 and 1001. Is there an error in reception? Justify with method used. (2 marks)**

   (c) **Consider the generator G = 1001. Determine if there is any error (show step by step check) if the Received D+R is 101010101, when D is 101010. (2 marks)**

3. **Provide the message exchange sequence (highlighting the flag bits, sequence/ack numbers) between two hosts Host A and Host B that intend to exchange data using TCP. After exchange the TCP connection is closed.**

   In between the opening and close of the connection, suppose that Host A received one segment from Host B containing bytes 0 to 465 and another segment containing bytes 800 through 900. For some reason, Host A has not yet received bytes 466 through 799. The third segment is out of order. Assume the close of connection is done after all segments are received successfully.

4. **Host A (192.168.10.101) is connected to a default gateway G1, and the internal subnet is 192.168.XXX.0/24. G1 is connected via two Routers R1, and R2 to reach end Server B. Assume G1 and R1 are connected on subnet 14.15.16.0/24. R1 and R2 is connected on subnet 32.33.34.0/24. R2 and Server B (40.41.42.104) are connected on subnet 40.41.42.0/24. Assume UDP data flow exists between Host A and Server B. (NOTE : XXX is your Roll number).**

   (a) **How many hops does the packet need to travel?**

   (b) **What will be the MAC header contents at first hop. (make suitable assumptions)**

   (c) **Will MAC header contents change every hop? if so what will change?**

   (d) **What will the IP header contents at first hop (make suitable assumptions, show key fields)**

   (e) **Will IP header contents change every hop? if so what will change?**

   (f) **What will be the UDP header contents at first hop (make suitable assumptions)**

   (g) **will UDP header contents change every hop? if so what will change?**

5. Consider distributing a file of $F = 25$ Gbits to N peers. The server has an upload rate of $u_s = 50$ Mbps, and each peer has a download rate of $d_i = 4$ Mbps and an upload rate of u. For $N = 10$, 100, and 1,000 peers, and $u = 500$ Kbps, 1 Mbps, and 2 Mbps, prepare a chart giving the minimum distribution time for each of the combinations of N and u for both client-server distribution and P2P distribution. (List the necessary formulas and explain values (2 marks), 2 marks each for the client server and Peer-to-peer distribution computation.)

6. Consider the topology shown in Figure 3. Denote the three subnets with hosts (starting clockwise at 12:00) as Networks A, B, and C. Denote the subnets without hosts as Networks D, E, and F.

   (a) Assign network addresses to each of these six subnets, with the following constraints: All addresses must be allocated from 114.XXX.154/22; Subnet A should have enough addresses to support 120 interfaces; Subnet B should have enough addresses to support 250 interfaces; and Subnet C should have enough addresses to support 120 interfaces. Of course, subnets D, E and F should each be able to support two interfaces. For each subnet, the assignment should take the form a.b.c.d/x or a.b.c.d/x − e.f.g.h/y. (NOTE : XXX is your Roll number) - 3 marks

   (b) Using your answer to part (a), provide the forwarding tables (using longest prefix matching) for each of the three routers. 3 marks
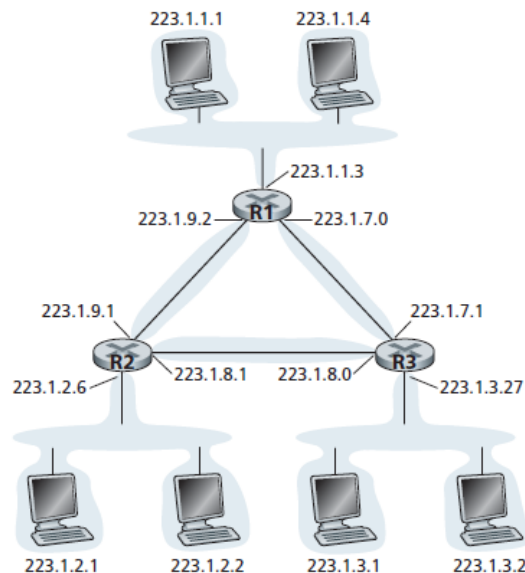

Figure 3: 3 Routers and 6 Sub nets (Fig 4.17 Kurose and Ross)