CS 742 Computer Communication Networks Final Exam - Name: _____
Fall 2002

Part 1: (75 points - 3 points for each problem)

(C) 1. H.323 is a (A) hardware (B) network architecture (C) protocol (D) software

(A) 2. A link is working at 20 MHz. Each bit data is encoded in 4 pulses. What is the data transfer rate for this link?
(A) 5 Mbps (B) 10 Mbps (C) 20 Mbps (D) 80 Mbps.

(C) 3. Which framing approach is used in SONET?
(A) character stuffing (B) bit stuffing (C) clock-based framing (D) frequency framing

(A) 4. Which statement about IEEE 802.11a is incorrect?
(A) It operates at radio frequencies 2.4 GHz. (B) It uses OFDM modulation.
(C) It makes possible data speeds as high as 54 Mbps. (D) None of above

(D) 5. Which is not examples of virtual circuit technologies?
(A) X.25 (B) Frame Relay (C) ATM (D) None of above.

(A) 6. When the Packet InterNet Groper (ping) is executed, which type of message is transmitted:
(A) an ICMP Echo Request (B) an ICMP Time Request (C) an ICMP Redirect (D) None of above

(B) 7. What is the header size of a IPv6 packet?
(A) 20 bytes (B) 40 bytes (C) 48 bytes (D) 60 bytes

(D) 8. Which address is shown when we issue the command: `ping localhost`?
(A) the IP address of the machine (B) 0.0.0.0 (C) 127.0.0.0 (D) 127.0.0.1

(D) 9. Which byte order is used in the Internet protocols?
(A) forward-endian (B) reverse-endian (C) little-endian (D) big-endian

(C) 10. In which function do we specify PF_UNIX or PF_INET?
(A) connect (B) listen (C) socket (D) bind

(B) 11. Which function is not used in UDP socket programming in C?
(A) bind (B) listen (C) socket (D) recvfrom

(B) 12. A DHCP server can be used to provide the same functionality as a(n):
(A) ARP server (B) RARP server (C) TFTP server (D) None of the above

(D) 13. The Internet Protocol (UDP) provides a delivery service that is:
(A) connection-oriented and reliable (B) connectionless and reliable
(C) connection-oriented and unreliable (D) connectionless and unreliable

(D) 14. Which is a lossy compression method?
(A) RLE (B) DPCM (C) LZ (D) None of above

(A) 15. Which is a security protocol related to HTTP?
(A) TLS (B) PGP (C) RSA (D) None of above

(C) 16. Which type is set to query the mail exchange in nslookup?
(A) CNAME (B) HINFO (C) MX (D) NS

(B) 17. The listen function does not convert an unconnected socket into a
(A) passive socket (B) active socket (C) connected socket (D) proper socket

(A) 18. Server handling multiple clients is not referred as a(n)
(A) iterative server (B) concurrent server (C) multi-threaded server (D) forked server

(C) 19. Which is not a I/O multiplexing function in C socket programming?
(A) select (B) poll (C) signal (D) FD_SET

(A) 20. IPv6 represents local loopback address as
(A) ::1 (B) ::127.0.0.0 (C) ::0 (D) None of above

(D) 21. Name service related configurations can not be set in the following
(A) /etc/resolv.conf (B) /etc/nsswitch.conf (C) /etc/hosts (D) /etc/sysctl.conf

(B) 22. IPv6 DNS records use following syntax for address records
(A) A (B) A6 (C) INET6 (D) AF_INET6

(A) 23. In IPv6, address :: refers to
(A) unspecified address (B) local loopback (C) multicast address (D) broadcast address

(C) 24. The ping and traceroute utilities use
(A) TCP sockets (B) UDP sockets (C) raw sockets (D) IP sockets

(B) 25. The following utility can be used to monitor network traffic in real-time :
(A) netstat (B) tcpdump (C) route (D) ifconfig

Part 2: (125 points)

1. Briefly explain these terminologies. If they are acronyms, also write what they stand for. (15 points)
   (a) **OSPF** Open Shortest Path First is a router protocol used within larger autonomous system networks
   (b) **DPCM** Differential Pulse Code Modulation is a compression alogrithm by recording the difference between the current and a reference symbol.
   (c) **SMTP** Simple Mail Transfer Protocol is a protocol used in sending and receiving e-mail.
   (d) **PGP** Pretty Good Privacy is a program used to encrypt and decrypt e-mail over the Internet.
   (e) **RTCP** The Real-Time Control Protocol is used to monitor and control real-time data transfer using the Real-Time Transport Protocol (RTP).
2. Complete the following table listing the seven layers in the OSI 7-Layer Reference Model. Then, identify three of the four layers used in the TCP/IP protocol suite (write TCP/IP beside them). Finally, identify where the following protocols belong: TCP, UDP, IP, ICMP, PPP, TLS, HTTP. (10 points)
   - Layer 7: Application Layer - HTTP (TCP/IP)
   - Layer 6: Presentation Layer - TLS
   - Layer 5: Session Layer
   - Layer 4: Transport Layer - TCP, UDP (TCP/IP)
   - Layer 3: Network Layer - IP, ICMP (TCP/IP)
   - Layer 2: Data Link Layer - PPP (TCP/IP)
   - Layer 1: Physical Layer

3. Using the divisor polynomial $x^3 + 1$ for CRC, what frame will be transmitted for the data M = 11000011? (6 points)
Ans: M(x) = 11000011, C(x) = 1001, r = 3

```
       11011000
      ------------
1001 )11000011000
       1001
       ----
        1010
        1001
        ----
          1101
          1001
          ----
           1001
           1001
           -------
               000
```

So the transmission frame T(x) is 11000011000

4. A PDA is transmitting a video of 2 x 3 inch at a resolution 50 pixels per inch, 2 bytes/pixel color encoding and 30 frames/second.

   (a) Calculate the bandwidth necessary for transmitting in real time.

   (b) Suppose the PDA can transfer up to 30 Mbps. Without loss of the resolution and color, how many frames per second can it transfer?

   (6 points)
   Ans: A frame size is $2 \times 3 \times 50^2 \times 2 \times 8 = 0.24$ Mbps

   (a) $0.24 \times 30 = 7.2$ Mbps

   (b) $30/0.24 = 125$ frames/s

5. Consider the following 6over4 tunnel diagram.

IPv4: 156.26.10.125		IPv4: 208.19.223.30
Dual Stack Host 1	⇐ IPv4 Infrastructure ⇒	Dual Stack Host 2
IPv6: 3ffe:2900:1:9::2/128		IPv6:

   What IPv6 address should be assigned to Host 2 to get the tunnel established properly ? (5 points)

   Ans: 3ffe:2900:1:9::1/128 or 3ffe:2900:1:9::3/128 could be assigned because the subnet address consists of 128 bits.

6. Suppose a router has built up the routing table as shown in the following table. The router can deliver packets directly over interfaces eth0 and eth1, or it can forward packets to other routers in the table.

Destination	Netmask	Gateway
156.26.10.0	255.255.255.192	eth0
156.26.10.128	255.255.255.128	eth1
156.26.0.0	255.255.0.0	156.26.10.1
0.0.0.0	0.0.0.0	156.10.1.30

   Describe what the router does with a packet addressed to each of the following destinations: (6 points)

   (a) 156.26.10.66 - deliver packets directly through eth0

   (b) 156.26.10.226 - deliver packets directly through eth1

   (c) 168.130.12.27 - forward to the router at 156.10.1.30

7. An organization has a class C network 192.168.1 and wants to form subnets for 4 departments, with hosts as follows: (12 points)

A	78 hosts
B	36 hosts
C	20 hosts
D	18 hosts

(a) There are 152 hosts in all. Give a possible arrangement of network and subnet masks to make this possible.

(b) Suggest what the organization might do if the department D grows to 34 hosts.

Ans:

(a)

Department	Network	Netmask	IP Addresses
A	192.168.1.0/25	255.255.255.128	128
B	192.168.1.128/26	255.255.255.192	64
C	192.168.1.192/27	255.255.255.224	32
D	192.168.1.224/27	255.255.255.224	32

(b) These are possible choices: either assign multiple subnets to single departments, abandon subnets and buy a bridge, or let C and D use the same subnet. Here is a possible deployment giving A two subnets, of sizes 64 and 32; every other department gets a sigle subnet of size of the next highest power of 2:

Department	Network	Netmask	IP Addresses
A	192.168.1.0/26	255.255.255.192	64
A	192.168.1.64/27	255.255.255.224	32
B	192.168.1.96/26	255.255.255.192	64
C	192.168.1.160/27	255.255.255.224	32
D	192.168.1.192/26	255.255.255.192	64

8. For the network 192.48.24.0/21, answer the following questions: (9 points)

   (a) How many IP addresses can be allocated?

   (b) What is the last IP address?

   (c) What is the netmask?

   Ans:

   (a) $2^{32-21} = 2^{11} = 2048$.

   (b) $(31 + 1 - 24) \times 256 = 2048 \Rightarrow$ 192.48.31.255.

   (c) The host ranges from 192.48.24.0 to 192.48.31.255. The first, second, and forth part of the netmask are 255, 255, and 0, respectively. The third part of the netmask $256 - 2^{24-21} = 248$. Hence, the netmask is 255.255.248.0.

9. For True or False questions, if it is false, explain why. (10 points)

   (a) True or False. The InetAddress.getByName method in Java determines the IP address of a host. (3 points)

   (b) True or False. If the client tries to write to a closed socket in C, the SIGKILL signal is generated. (3 points)

   (c) What are differences between the shutdown and close functions in C socket programming? (4 points)

   Ans:

   (a) True.

   (b) False. The SIGPIPE signal is generated.

   (c) There are two limitations in the close function that can be avoided by the shutdown function.

      i. The close function decrements the descriptor's reference count and closes the socket only if the count reaches 0, in shutdown this is not the case you can close the socket immediately.

      ii. The close function terminates both directions of data transfer while the shutdown function

10. The round trip time (RTT) for a TCP segment can be estimated by using the formula: α * old_RTT + (1 - α) * Sample. Starting with an estimate of old_RTT = 24 msec., compute the estimates for RTT if the first three segments transmission actually require 30, 36, and 33 msec., respectively. Assume α = 0.5. (6 points)

Segment	Estimated RTT	Actual RTT
1	24	30
2	$24 \times 0.5 + 30 \times 0.5 = 27$	36
3	$27 \times 0.5 + 36 \times 0.5 = 31.5$	33
4	$31.5 \times 0.5 + 33 \times 0.5 = 32.25$	

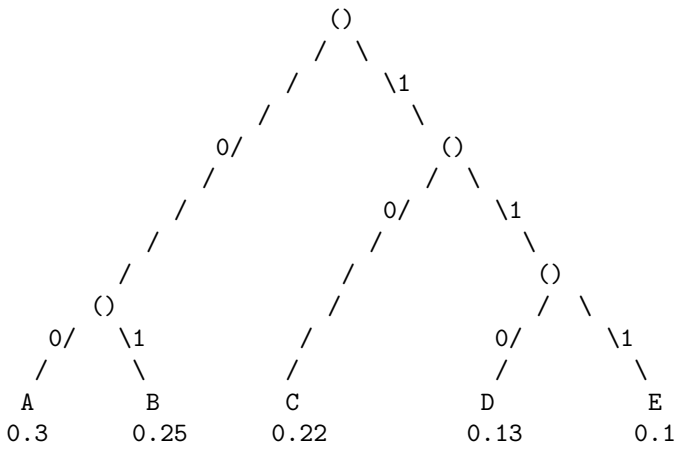
11. Suppose that an alphabet has five symbols, A, B, C, D, and E, and they occur with probability 0.3, 0.25, 0.22, 0.13, and 0.1, respectively. (7 points)

    (a) Compute a Huffman code for each symbol.

    (b) How could the string 'ACE' be encoded?

    Ans:

    (a)



    A - 00 B - 01 C - 10 D - 110 E - 111

    (b) The string 'ACE' can be 0010111.

12. Encrypt the following plaintext using a transposition cipher based on the key `MONKEY`. (7 points)
    plaintext = H A V E A N I C E D A Y
    ciphertext = A A E D H I V E A C N Y

```
M O N K E Y
3 5 4 2 1 6
H A V E A N
I C E D A Y
```

13. If we use the ping command to request the remote machine, list 4 possible reasons why we do not get any response from the remote machine. (8 points)
    Ans:

    (a) A firewall disabled the ping command on either local or remote side.

        i. A firewall involved dropping all ICMP packets

        ii. A firewall involved dropping only ICMP packets of the ECHO-REQUEST type.

    (b) The link between the local and remote machines is down.

    (c) The remote host is not alive.

    (d) The default gateway experience network problems.

14. Consider this clip of code for a UDP socket `sockfd`: (8 points)
UDP client side

```
for(;;) {
   sendto(sockfd, ... );
}
```

UDP server side

```
for(;;) {
 recvfrom(sockfd, ... );
}
```

If we put a printf statement in the client code after each sendto() statement within loop, does this change the percentage of received packets at server side? If so, Why? If we put a printf statement in server side after each recvfrom() statement, does this change the percentage of received packets at server side? If so, then why?

Ans:

(a) Putting a printf in the client should introduce a delay between each datagram to be sent, allowing the UDP server to recieve more datagrams.

(b) Putting a printf in the server should cause the server to loose more datagrams.

15. Consider the following clip of C code: (10 points)

```
// Shared struct definition between the client and server code.
// prog.h

struct args {
  long arg1;
  long arg2;
};

struct result {
  long sum;
};
```

Consider this client C function code connects to server:

```
void client (int sockfd) {

  struct args    a;
  struct result  r;
  char sendline[400];

  // initialize struct args variables.
  a.arg1 = 10023;
  a.arg2 = 32121;

  // write to server using sockfd passed.
  write(sockfd, &args, sizeof(args));

  if (read(sockfd, &result, sizeof(result)) != 0 )
    printf("sum = %ld\n", result.sum);
}
```

Consider this Server C function to add those two integers passed by the client and write back the result.

```
void server (int sockfd) {

  struct args   a;
  struct result r;
  ssize_t n;

  for (;;) {
    if ( (n = read(sockfd, &args, sizeof(args))) == 0) return;

    result.sum = a.arg1 + a.arg2;

    // write back the result to client
    write(sockfd, &result, sizeof(result));
  }
}
```

Consider the fact that the socket was properly established and structures were properly initialized and also the code was properly compiled. What are the potential problems caused by the above code? How can those problems be solved? If the same program are written in Java, will the same problem persist or not? If so, why?

Ans: If the server and client run on two different architectures, then the above code has these potential problems. Consider SPARC implements big-endian while Intel x86 does little-endian. This could lead the following problems:

(a) Two binary integers are sent across the socket in the little-endian format and recieved as big-endian integers by the server or vice versa. Because of this, the integer summation may fail as different operating systems store the C data type long integer differently. For example, SPARC uses 64 bits to store a long integer while Intel uses 32 bits. There is no guarantee that an integer on different operating systems use the same size.

(b) Different OS socket implementations pack structures (struct) differently depending on the number of bits used for the various data types and alignment restrictions of machine. Therefore, it is never wise to send binary structures across a socket.

The most suitable solution is to pass all numeric data as a text or string. and then convert the text back into an integer or long using atoi or atol functions.

The problem won't occur in Java as the JVM guarantee the interportability between different architectures.