1. (1 point, 1 min)
Why are the Atlanta Hawks in the NBA playoffs?
(a) They are the best team in the NBA.
(b) They are the best team in the eastern conference.
(c) They are the best team in the western conference.
(d) Because most teams in the eastern conference suck!
(e) How am I supposed to know? I am taking your class, right?
Networking

2. (5 points, 10 mins)
A packet header consists of the following fields:

- Destination address 8 bytes
- Source address 8 bytes
- Number of packets in message 4 bytes
- Sequence number 4 bytes
- Actual packet size 4 bytes
- Checksum 4 bytes

Assuming that the maximum packet size is 1574 bytes, what is the maximum payload in each packet?

3. (10 points, 10 mins)
Given the following:

- Sender overhead = 1 ms
- Message size = 200,000 bits
- Wire bandwidth = 100,000,000 bits/sec
- Time of flight = 2 ms
- Receiver overhead = 1 ms

Compute the observed bandwidth. Recall that the message transmission time consists of sender overhead, time on the wire, time of flight, and receiver overhead. Ignore ACKs.
4. (10 points, 10 mins)
Assume that a network loses 1 in 5 packets on an average. For a message that consists of 200 packets, determine the total number of packets sent by the sender to successfully complete the message transmission. Use only integral packet losses ignoring fractional loss of packets (e.g., if 2.7 packets are lost, treat that as 2 packets lost in your calculation). Ignore ACKs.

5. (5 points, 10 mins)
Fill in the blanks with one of the following terms that best matches the desired functionality (no reuse of terms):
   hub, switch, router, NIC, fiber

a. Sits inside your computer and allows it to connect to the network
   __________

b. Allows computers to be connected together with no collision of packets
   __________

c. Allows computers to be connected together but with collision of packets
   __________

d. Physical medium for transporting bits between computers
   __________

e. Allows computers to be connected together across the Internet
   __________
6. (5 points, 5 minutes)
Match the right hand side with the left (fill in the blank with the appropriate letter from the right hand side, no reuse)

1. High network load __________________ a. Sequence number
2. Low network load __________________ b. Acknowledgements
3. Unreliable packet delivery _____________ c. Token ring
4. Variable message size _______________ d. Ethernet
5. Out of order packet arrival _____________ e. Scatter/gather

File system
7. (10 points, 10 mins)

Given the following:
Number of cylinders on the disk = 10,000
Number of platters = 3
Number of surfaces per platter = 2
Number of sectors per track = 1024
Number of bytes per sector = 512
Disk allocation policy = contiguous cylinders

(a) How many cylinders should be allocated for a file of 7 Mbyte (M = 2^20)

(b) How much is the internal fragmentation caused by this allocation?
8. (9 points, 10 mins)
Given the following i-node structures, fill in the blanks (there are 7 of them). Type of i-node can be one of directory, data, or sym-link.

The Unix commands that gives rise to the following i-node structure:

```
    cd   /tmp
    touch    tupac1
    ln    tupac1    tupac4
    ln   -s    tupac1    tupac2
    ln    tupac2    tupac3
```

20 i-node for tmp

```
Type = __________

    tupac1   30
    tupac2   40
    tupac3   40

30 i-node for __________

Type = __________

Refcount = __________

40 i-node for __________

Type = __________

Refcount = __________
```
9. (10 points, 10 mins)
This question is with respect to the disk space allocation strategy referred to as FAT.

- Assume there are 10 data blocks numbered 1 through 10.
- There are three files currently on the disk:
  - *joel* occupies disk blocks 4, 3, 1, in that order;
  - *tupac* occupies disk blocks 2, 6, in that order;
  - *mozart* occupies disk blocks 8, 10, in that order;

Fill the name table and FAT metadata, using the following metadata convention

- 0 for unused block;
- block number for next disk block of the file;
- -1 for the last block of a file

**Answer:**

<table>
<thead>
<tr>
<th>Name</th>
<th>Disk Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>joel</td>
<td></td>
</tr>
<tr>
<td>tupac</td>
<td></td>
</tr>
<tr>
<td>mozart</td>
<td></td>
</tr>
</tbody>
</table>

![FAT metadata diagram](image)
Disk recording and disk read time
10. (5 points, 10 mins)
Distinguish between zoned bit recording and normal (non zoned) recording of the disk.

11. (5 points, 10 mins)
Given the following about a disk:

Seek time     =  6 ms
Rotational speed =  7500 RPM
Platters      =  3
Surface per platter =  2
Tracks per surface =  1024
Sectors per track =  128
Recording density =  512 bytes per sector

What is the time to read 4 consecutive sectors from the disk? Recall that the time to read any sector on the disk is given by the sum of the seek time, the time needed to get the head over the desired sector, and the time to read the sector itself.
12. (5 points, 10 mins) In a computer bus connecting processor and memory, explain the role performed by each of the following:

(a) arbitration lines

(b) command lines

(c) address lines

(d) data lines

(e) interrupt lines
Threads and synchronization

13. (5 points, 10 mins) (choose one correct choice in each of the following)

(a) The contents of a TCB
   1. Same as PCB
   2. Subset of PCB
   3. Superset of PCB
   4. Contains the thread specific information not in the PCB

(b) Ensuring that all the threads of a given process share an address space in an SMP is
   1. Impossible
   2. Trivially achieved since the page table is in shared memory
   3. Achieved by careful replication of the page table by the operating system for each thread
   4. Achieved by the hardware providing cache consistency

(c) Deadlock
   1. Is a condition where threads are not using mutex locks
   2. Is a condition where all the locks variables are in use
   3. A lock variable that is dead
   4. Is a condition where one or more threads are waiting for an event that will never happen

(d) \[ \text{while (state == BUSY) thread_cond_wait (c, m);} \]
    \[ \text{state = BUSY;} \]
    Replacing the “while” by “if” in the above construct for exclusive access to a resource
   1. Will always result in violating the intended synchronization
   2. Will never result in violating the intended synchronization
   3. May sometimes result in violating the intended synchronization

(e) Keeping the TLBs consistent in an SMP
   1. Is the responsibility of the user program
   2. Is the responsibility of the hardware
   3. Is the responsibility of the operating system
   4. Is impossible
14. (10 points, 10 mins)
Given the following procedure called `binary-semaphore`:

```c
static int shared-lock = 0; /* global variable to both T1 and T2 */

/* shared procedure for T1 and T2 */
int binary-semaphore(int L)
{
    int X;
    X = test-and-set (L);
    /* X = 0 for successful return */
    return(X);
}
```

Two threads `T1` and `T2` execute the following statement simultaneously:
`MyX = binary_semaphore(shared-lock);`
where `MyX` is a local variable in each of `T1` and `T2`.

What are the possible values returned to `T1` and `T2`?
15. (5 points, 10 mins)

Explain the difference between write-invalidate and write-update multiprocessor cache coherence strategies.