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Problem	Points	Lost	Gained	Running Total	TA
1	1				
2	5				
3	10				
4	10				
5	5				
6	5				
7	10				
8	9				
9	10				
10	5				
11	5				
12	5				
13	5				
14	10				
15	5				
Total	100				

You may ask for clarification but you are ultimately responsible for the answer you write on the paper.

Please look through the entire test before starting. WE MEAN IT!!!

Illegible answers are wrong answers.

Show your work in the space provided to get any credit for problem-oriented questions.

Good luck!

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?

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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.

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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

    _____

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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?
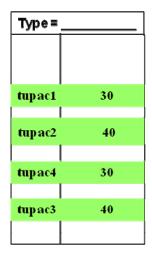
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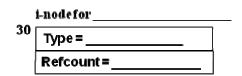
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8.(9 points, 10 mins)
Given the following i-node structures, fill in the blanks (there are 7 of them). Type of i-node can be one of directory, data, or sym-link.

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
tupac4	30
tupac3	40

i-node for _____

30

Type = _____
Refcount = _____

i-node for _____

40

Type = _____
Refcount = _____

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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:

Name table

Name	Disk Address
joel	_____
tupac	_____
mozart	_____

FAT metadata

#	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

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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.

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I/O
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

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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)   **while (state == BUSY) thread_cond_wait (c, m);**
       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

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14. (10 points, 10 mins)
Given the following procedure called **binary-semaphore**:

```
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**?

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15. (5 points, 10 mins)

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