Principles of Computer System Design
Midterm Exam #2
Mon, Nov 17th, 2014

NAME:

UFID:

Please read each question carefully, to avoid any confusion. This exam should have 8 pages; before you begin, make sure your copy contains all pages. The exam is closed book, closed notes. Each question has its number of points identified in brackets.

GOOD LUCK!

QUESTION	***POINTS SCORED***
1 [30]	
2 [30]	
3 [30]	
4 [10]	
TOTAL	

1) [30] Fault tolerance:

i) [5] Suppose a hard disk has MTTF=30 years. Assume it fails according to the memory-less model described in class, where R(t)=e(-t/MTTF). What is the probability that the disk has failed, at time t=MTTF? What is the conditional failure rate at time t=MTTF/2?

ii) [5] Suppose you use a distance-3 Hamming code in a memory module. Is a *two-bit* error *detectable*? Is it *maskable*? Briefly explain why or why not.

iii) [5] Describe one scenario where backward error-correction may not be possible.

iv) [15] Consider the layered approach to disk fault tolerance discussed in class, with the raw, fail-fast, careful, and durable layers. For each of the faults below, describe in which layer it is detected (if detection is possible) and how. Also describe in which layer it is masked (if masking is possible), and how.

- Fault in writing to a sector due to temporary hazard (e.g. dust)

- Seek error

- Fault in reading from a sector whose contents have decayed

2) **[30]** Networking and cross-cutting questions:

i) [8] Consider an IP-layer router with a single 1000-entry FIFO queue; suppose the average service time to process and forward a packet is 1ms, and that both arrival and service follow the exponential memory-less process discussed in class. What is the expected average latency for packet routing when utilization is 40%?

ii) [7] Suppose a link-layer fault (noise on a link) causes an undetectable error where an IP packet's destination address changes from IPa to IPb. Assume the packet is delivered to the machine B which has address IPb, can the network layer in B detect this error? Could an end-to-end protocol detect this error? Briefly explain.

iii) [8] Consider a network with a sender (S), a receiver (R), and two network-layer forwarders (F1,F2) connected by three links (L1 between S-F1, L2 between F1-F2, L3 between F2-R). Suppose F1, F2 use a link-layer protocol with acknowledgments and retries for reliable delivery frames. If "S" sends exactly one packet to R, is it ever possible R receives a duplicate? Explain why or why not.

iv) [7] A fault in the manufacturing of a network interface has resulted in two computers A and B with the exact same station identifier (Ethernet address) plugged in to the same Ethernet network. The computers are assigned different IP-layer addresses, IP-A and IP-B. Suppose a third computer C issues an ARP request for IP-A. Does C receive a response from B? If C subsequently sends a packet with destination IP-A, does B receive it?

3) [30] Performance

i) [5] What is one advantage of a first-come-first-serve scheduler for hard disks, compared to a shortest-seek first scheduler?

ii) [5] Would an elevator scheduler policy be recommended for scheduling threads to CPU processors? Briefly explain.

iii) [5] Describe one example of priority inversion.

iv) Consider a disk with a single platter, a total of 10,000 tracks, 100,000 sectors per track, rotates at 7200 RPM, sectors are 4KB in size, and the magnetic head step-motor takes .1ms to move between adjacent tracks.

iv.a) [5] What is the peak throughput achievable? State your assumptions.

iv.b) [5] What is the worst-case latency to read a sector? State your assumptions.

iv.c) [5] Suppose your system is intended to run applications that use very large files. What support from the O/S file system layer would be important to exploit this pre-fetching policy?

4) [10] True (T) / False (F) questions

i) NAT is a link-layer protocol
[T / F]

ii) The rate monotonic scheduler does not employ pre-emption
[T / F]

iii) The throughput of a pipeline is no larger than that of the stage with the minimum throughput
[T / F]

iv) A fail-fast system is able to detect and report an error at its interface
[T / F]

v) Request latency is linearly proportional to arrival rate in a queuing system
[T / F]