

CS 140: Operating Systems and Systems Programming

Final Exam

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In recognition of and in the spirit of the Stanford University Honor Code, I certify that I will neither give nor receive unpermitted aid on this exam.

Name (please print): _____

Signature: _____

- This exam is **closed notes** and **closed book**.
- **No collaboration** of any kind is permitted.
- You have **180 minutes** to complete the exam.
- There are **11 questions** totalling **100 points**. Some questions have multiple parts.
- Please check that you have all **7 pages**.
- Before starting, **write your initials on each page**, in case they become separated during grading.
- Please print or **write legibly**.
- Answers may not require all the space provided. Complete but **concise answers are encouraged**.
- **SCPD students:** If you wish to have the exam returned to you at your company, please attach an SCPD routing slip. Otherwise, we will assume that you will pick up your exam on campus. Routing slips can be obtained just outside the classroom (if you take the exam on campus) or on the SCPD website.

Question	Points	Score
1	8	
2	8	
3	12	
4	10	
5	8	
6	12	
7	4	
8	12	
9	9	
10	8	
11	9	
Total	100	

3. Old Unix-like systems did not provide any primitives intended for synchronization of user processes, but they did provide pipes. A pipe is a channel for transmitting a stream of data, based on a fixed-sized buffer (often 4 kB). Reading an empty pipe blocks until data is written. Writing to a pipe whose buffer is full blocks until data is read.

(a) (6 points) Explain how to implement a semaphore using a pipe. (Hint: take advantage of the pipe's blocking semantics.)

(b) (6 points) A semaphore implemented as a pipe may deadlock in a situation where a conventionally implemented semaphore would not. Describe the situation.

4. (10 points) `fd` is an open, writable file descriptor for a zero-length file in a Unix-like file system. Its file pointer is set to an offset of 10^9 bytes. What would each block written by the following function call contain?

```
write(fd, &data, 1);
```

5. (8 points) Professor Bob designs a file system that allocates file data using a variable-length array of extents. Suggest two advantages and two disadvantages of this scheme compared to the data allocation schemes discussed in class.

6. One-time passwords.

(a) (6 points) Are one-time passwords vulnerable to replay attacks when used for authentication on physical machines? On virtual machines?

(b) (6 points) Are one-time passwords vulnerable to man-in-the-middle attacks on physical machines? On virtual machines?

7. (4 points) Why can salts be made public?

8. Alice and Bob have previously exchanged public keys. Now Alice wants to send a confidential message to Bob.

(a) (6 points) What should Alice do? Fill in each blank with one of the following words: signs, encrypts, Alice, Bob, public, private.

Alice _____ the message with _____'s _____ key
then _____ the result with _____'s _____ key.

(b) (6 points) Could Alice reasonably perform these operations in the opposite order? Why or why not?

9. (9 points) An architecture supports 4 kB pages and 4 MB superpages. A process uses 4 MB of virtual memory. Give three reasons why many 4 kB pages might be a better way to map the region than one 4 MB superpage. Assume that the process's memory is properly aligned for a superpage.

(1)

(2)

(3)

10. (8 points) We wish to increase the size of a RAID array by adding one new disk. Is it easier to add the new disk if the array's RAID level is 4 or 5, and why? You may assume the new disk contains all zeroes.

11. Networking.

- (a) (3 points) Wired links, such as Ethernet, FDDI, and ATM, do not normally feature encrypted or reliable transmission. What is the justification for this design decision?

- (b) (6 points) Many wireless links, including all variants of 802.11, do have encryption and reliability features. In each case, why make a different design decision for wireless?

encryption:

reliability: