NJIT New Jersey's Science & Technology University

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EXAM 4 (120MIN)

CS332-005
FALL 2019
350 POINTS

Name: .....

ID Number (last 4 digits): ..... **Exam Type:** ...A... **Exam Number:** .....

Grade: 1: ... 2: ... 3: ... 4: ... 5: ... 6: ... 7: ... 8: ... Total: .....

THERE ARE 5 (FIVE) PAGES THIS PAGE INCLUDED IN THIS EXAMPAPER

Solve all the problems in the space provided in this exampaper

Read the Instructions and Problems carefully; do not complain later

Make sure you sign the exam before you turn it in

Unsigned exams are marked with grade 0 (zero).

Signature .....

List of useful formulae

NOTE: This exam is open (paper-version) textbook. Only pens/pencils and this exampaper are allowed on the table. For scratch paper, use the rear side of the exam.

WARNING: MOBILE PHONES OR DEVICES PER HANDOUT 1 (SYLLABUS) MUST BE POWERED DOWN AND IN BACKPACK/BAG. OTHERWISE SCREEN FACING THE FLOOR AND ON THE FLOOR.

Minimal answer. Instead of saying or writing 0.001s write 1ms, instead of 30 days write one month, and instead of saying 1,000cm write 10m as answers to questions.

5X means '5 times larger than'. For example 20 is 5X larger than 4. '5X or less' means 2X or 3X or 4X or 5X.

Choose one 25point problem of your choice. Write BONUS next to the Problem header of that problem. Whatever points you receive for that problem, those points will be doubled. if you write BONUS on two or more problems, or to an non-25-point problem, or you forget to do it, no mercy, no complaints. You have been warned!

Problem 1. (50 POINTS)

TRUE or FALSE. Circle one and only one. Any marks with a T or F anywhere else would be considered wrong.

1. **TRUE** **FALSE**. A primary objective of an OS is to manage hardware resources and provide a useful interface of those resources to programmers.
2. **TRUE** **FALSE**. Every process in Linux is also assigned a unique PPID (parent process ID), different from the PPID of every other process.
3. **TRUE** **FALSE**. Process management code in the kernel is sometimes executed in user-mode.
4. **TRUE** **FALSE**. First come first served process next is a preemptive policy.
5. **TRUE** **FALSE**. Main memory is a resource managed by an operating system.
6. **TRUE** **FALSE**. It is possible for a process to have its state changed from BLOCKED directly into EXIT.
7. **TRUE** **FALSE**. A thread spawn by a process shares stack data with the process that created the thread.
8. **TRUE** **FALSE**. When a page fault is issued, the pager brings in a single page to resolve the page fault.
9. **TRUE** **FALSE**. Each process residing in main memory has its own page table.
10. **TRUE** **FALSE**. Segmentation can suffer from external fragmentation.

Problem 2. (25 POINTS)

Consider a memory system with a cache and main memory. It takes 10ns to access the cache, and 100ns to access the main memory. If the effective (memory) access time is 200% of the cache access time, what is the hit ratio H?

Problem 3. (25 POINTS)

You execute the following program. Assume all forks succeed in executing. How many hello will be output?

```
#include <stdio.h>
#include <sys/types.h>
int main(void) {
    printf("hello\n");
    fork();
    return(0);
    fork();
    fork();
    fork();
 }
```

Problem 4. (50 POINTS)

A CS332 year is 12 months, each month has 30 days, and each day 24 hours. A system (eg data center) with 1,000 HDD has MTBF of 1,440,000 hours. How often does a HDD failure will occur in that system? (Give a minimal answer.)

Problem 5. (50 POINTS)

Answer briefly or as specified the following questions. The shorter the correct answer is the more of the points you will receive.

1. Give a definition of the term thread in mo more than five words.

2. Harvard von-Neumann. Programs are stored in one memory, data are stored in another different memory. What architecture is it? Circle the answer.

3. A UNIX/Linux fork that succeeds what positive value does it return to the parent process?

4. What are the two types of locality (of reference)?

5. What kind of fragmentation can appear in paging?

6. The present bit is one in a PTE (page table entry) for a memory access that is trying to retrieve the frame number stored in it. What will happen next ?

7. What entity is called 'a program in execution'?

8. 1000 processes are running in an OS. In kernel space how many page table structures are there?

9. IN option ALFA , we read 1,000 files each one 4KiB in size (including metadata) from a HDD with average rotational latency of 5ms, average seek time of 15ms, and 100,000KiB/s transfer speed for read/write operations. In option BETA, we read one file of size 4,000KiB in size. When we compare the time for realizing option ALFA to realizing option BETA, write down using the numbers (1) through (6) all the statements that are correct among the ones shown below
   (1) ALFA is approximately 100X faster than BETA
   (2) ALFA is approximately 100X slower than BETA
   (3) ALFA and BETA have roughly the same performance
   (4) ALFA is approximately 1000X slower than BETA
   (5) ALFA is approximately 1000X slower than BETA
   (6) ALFA is (10X or less) faster than BETA
   (7) ALFA is (10X or less) slower than BETA
   (8) none of the above

10. In a monitor, who controls (i.e. deals with) mutual exclusion, the programmer or the OS (i.e. monitor)?

Problem 6. (50 POINTS)

For each of the following denary logical addresses, compute the page number and the offset for a 500B page first. Provide the answer in L=(P,T) form.
(a) address 512, (b) address 5123, (c) address 16123.

Problem 7. (50 POINTS)

A hard disk drive has the following specifications. How long does it take to read a 4KiB file? (Round up to ms.)

```
(P.1) Sector Size (given)                = 4KiB
(P.2) Average Seek Time (ms)             = 30ms
(P.3) Rotational Speed (RPM)             = 6000RPM
(P.4) Transfer Rate (KiB/s)              = 400KiB/s
(P.5) #sectors / track                   = 64 sectors/ track
(P.6) controller overhead (ms)           = 10ms
(P.7) DiskAccessTime (ms)                = ?
(P.8) TransferTime   (ms)                = ?
(P.9) Time-to-Read 4KiB (ms)             = ?
```

Problem 8. (50 POINTS)
A logical address space is 47-bit thus allowing processes to use up 2^{47}B each; the physical address space supports up to 2^{52}B. We ask you to complete the following missing table entries if we plan to translate 47-bit virtual addresses with three levels of a page table, fully utilized. (P1 = P2 = P3.)

```
(2.1) Logical Address (#bit)  FILLED-for-YOU = 47bit
(2.2) Physical Address (#bit) FILLED-for-YOU = 52bit
(2.3) Page size (# B)                        =
(2.4) Offset T (#bit)                        =
(2.5) #bit for frame in Phy. Address         =
(2.6) #B   in a page table entry             =  8B
      (+ one Present bit, one Modified bit)
(2.7) #entries in page table                 =
(2.8) (P1, P2, P3, T) #bit                   =  (    bit,   bit,    bit,    bit)
```