CS 450  
Operating Systems  
Final Exam.

This exam is closed notes and books. The exam is three hours long. There are nine questions, ten points for each for a total of 90.

1) Explain the two main functions of an operating system [10]

2)  
   a) What is multiprogramming? [2]  
   b) How does kernel code have more privileges than user code? [2]  
   c) What is the difference between a system call and a library call? [2]  
   d) Which of the following instructions should be allowed only in kernel mode? Check all appropriate. [4]  
      (a) Disable all interrupts.  
      (b) Read the time-of-day clock.  
      (c) Set the time-of-day clock.  
      (d) Change the memory map.

3) For the following graph describing the read() system call's execution. [10]

   a) Write a number on each one at the graph to specify their order.  
   b) This would be done with much less overhead in a Linux system as opposed to MINIX. Why
does MINIX 3 rely on kernel messages?

4) [10]
   a) When can a process be created? [4]
   b) In the following graph you can see the three scheduling states a process can be in. List an example event that triggers each transition. [6]

   ![Diagram of scheduling states: Running, Ready, Blocked]

5) [10]
   a) The following are steps that MINIX takes when performing a context-switch. Put them in the correct order.[6]

   a. Hardware loads new program counter from interrupt vector.
   b. C interrupt service constructs and sends message.
   c. Assembly language procedure sets up new stack.
   d. Hardware stacks program counter, etc.
   e. Message passing code marks waiting message recipient ready.
   f. Scheduler decides which process is to run next.
   g. Assembly language procedure saves registers.
   h. C procedure returns to the assembly code.
   i. Assembly language procedure starts up new current process.

   b) Give one pro and con for each of kernel-level threads and user-space threads? [4]

6) Consider a swapping system in which memory consists of the following hole sizes in memory order: 10 KB, 4 KB, 20 KB, 18 KB, 7 KB, 9 KB, 12 KB, and 15 KB. Which hole is taken for successive segment requests of

   (a) 4 KB
   (b) 2 KB
   (c) 12 KB

   for first fit? Repeat the question for best fit, worst fit, and next fit.

7) a) A machine has 48-bit virtual addresses and 32-bit physical addresses. Pages are 8 KB. How many entries are needed for the page table? [4]
   b) A system has a 32-bit logical address space. Each address refers
to a byte in memory. If the page size is 16 KB, and main memory size is 256 MB. What is the minimal size (in bytes) of the page table?

c) A small computer has 8 page frames, each containing a page. The page frames contain virtual pages A, C, G, H, B, L, N, D, and F in that order. Their respective load times were 18, 23, 5, 7, 32, 19, 3, and 8. Their reference bits are 1, 0, 1, 1, 0, 1, 1, and 0 and their modified bits are 1, 1, 1, 0, 1, 0, 1, and 1, respectively. What is the order that second chance considers pages and which one is selected? [6]

8) a. Define a deadlock [6]
   c. List the four conditions for deadlocks. [4]

9) a. What is Direct Memory Access? [3]
   b. List the three common structures of files. [3]
   c. A file's blocks can be allocated in one of two ways. List them and a pro and con for each. [4]

10) [10]
   a. List three advantages of segmentation:[3]
   b. Memory management and File management have some similarities. List two of those. [2]
   d. Order the following according to their place in the layers of the device I/O system of MINIX 3: [5]
      Device Drivers
      Interrupt Handlers
      Hardware
      User Processes
      Device-Independent Software

11) List the functions of device-independent software and an example for each. [10]