Operating Systems

Homework 1

Question 1

A user mode program can transfer control to the kernel by making a system call, such as 'read' or 'write'. This will trigger a software interrupt, causing the program execution to jump to the corresponding location as specified in the interrupt vector table. That location contains the necessary instructions to switch to kernel mode and execute the kernel's instructions.

Dividing by zero, executing an illegal instruction and attempting to access memory outside of the program's allocated range also trigger software interrupts.

Question 2

Advantages for building an operating system with a fixed hardware configuration include:

- The operating system does not need to spend time and space to detect hardware changes.
- It is easier to design the operating system with fixed hardware in mind.

Question 3

Question 3a

An example of an application of a hard real time system is a car engine control system, where missing a deadline can cause engine failure, therefore missing a deadline is unacceptable to the system, so it must use a hard real time system.

An example for the application of a soft real time system is a text messaging platform. If a deadline is missed by a few seconds when transmitting a message, the usefulness of the message is not zero, but the more delays there are, the worse the quality of the service.

Question 3b

1. An essential property of time sharing operating systems is the ability to perform multiple tasks simultaneously through the use of CPU scheduling.
2. An essential property of real time operating systems is the level of consistency regarding the time it takes from when it receives a task from a program until it completes the task.

Question 3c

Generating an interrupt, accessing the network card buffer, and setting up the timer are all privileged operations. Invoking a system call is not.

Question 3d

In an application, a function can be called, but the CPU moves the stack pointer and saves all the registers in memory then jumps to the address of the function.

In an application, dynamic memory can be allocated, but the main memory handles where it is stored and if there's enough available space for the requested amount of memory.

In an application, a file can be opened by passing the file location, but really the application has no idea which blocks of the secondary storage the file is stored in.

In an application, a string can be simply output to a console, but it does not care if the operating is using polling, interrupts, or DMA to handle system calls.

Question 3e

A. If the system displays “invalid user” (in case 1 and 2), then the user can make up to 62^n attempts to guess the username, and another 62^n to guess the password. Then to find the password, it will take up to 62^n guesses. In total it will take up to $62^n * 2$.

   However if the system only displays “invalid entry” the intruder will have to check every possible username against every possible password, so it will take up to $62^n * 62^n = 62^{2n}$ guesses.

B. When $n = 5$, it will take up to 1,832,265,664 attempts if the systems says the user is unvalid, or $8.39299366 * 10^{17}$ guesses if it doesn’t.

Question 4

Question 4a

DMA is asynchronous, polling is synchronous.

Question 4b

50 microseconds per interrupt * 4000 interrupts per page * 20 pages per minute = 4 seconds per minute.

Question 4c

30 cm/s = 300mm/s = 3000 interrupts per second = 6000 bytes per second = 6KB/s