CPSC/ECE 3220 – Summer 2018 – Final Exam **Name: __________________________**

>>>> No electronics allowed. <<<<

Word Bank for Chapters 11-14

Write one of the words or terms from the following list into the blank appearing to the left of the appropriate definition. Note that there are more words and terms than definitions. (1 pt. each)

absolute path	access control list	capability list	defragment	device driver
directory	extent	file	logical record	mirroring
path	partition	physical record	relative path	scrubbing
sector	seek	track	transaction	volume

1. ________________________ A circle of sectors on a disk surface.

2. ________________________ The string that identifies a file or directory.

3. ________________________ A named collection of data in a file system.

4. ________________________ The unit of data transfer for an application.

5. ________________________ Moving the disk arm over the desired track.

6. ________________________ The unit of data transfer for a physical device.

7. ________________________ A path name that is interpreted relative to the root directory.

8. ________________________ A list of (object, access rights) tuples held by a user or application.

9. ________________________ A path name that is interpreted relative to the current working directory.

10. _______________________ A collection of physical storage resources that form a logical storage device.

11. _______________________ A variable-size region of a file that is stored in a contiguous region on a disk.

12. _______________________ A list of human-readable names and a mapping from each name to a specific underlying file or directory.

13. _______________________ A list of (user, access rights) tuples held by an object, which may be stored explicitly or in a compressed format.

14. _______________________ Coalescing scattered disk blocks to improve spatial locality, by reading data from its present storage location and rewriting it to a new location.

15. _______________________ A process, thread, or procedure that translates between the high level abstractions implemented by the operating system and the hardware-specific details of I/O devices.

16. _______________________ Periodically reading the entire contents of a disk, detecting sectors with unrecoverable read errors, reconstructing the lost data, and writing the reconstructed data to spare sectors when the read errors are determined to be permanent.

<u>Kernel mode / User mode.</u> Circle ***one or both*** of K and U, as applies. (1 pt. each)

17. K / U Valid to set the hardware timer in this mode.

18. K / U Valid to set a Page Table Base Register in this mode.

19. K / U Valid to load a value from a thread's stack in this mode.

20. K / U Valid to execute a jump-to-subroutine instruction in this mode.

21. Identify the two major differences between a jump-to-subroutine instruction (i.e., procedure call instruction) and a syscall instruction (i.e., software interrupt or trap instruction). (2 pts.)

22. Most processors define an interrupt return (iret) instruction that can be used to change from kernel mode back to user mode. Identify the component(s) of an operating system in which this instruction would be used. (1 pt.)

<u>Program / Multithreaded Process / Thread.</u> Circle ***only one*** of P, MTP, or T, as applies. (1 pt. each)

23. P / MTP / T This object has a scheduling state (e.g., running, ready, waiting).

24. P / MTP / T This object has a one-to-one association with a program counter (PC).

25. P / MTP / T This object is the abstraction for protection provided by the operating system kernel.

26. P / MTP / T In a virtual memory paging system, this object has a one-to-one association with a page table.

True/False. Circle <u>only one</u> of T or F. (1 pt. each)

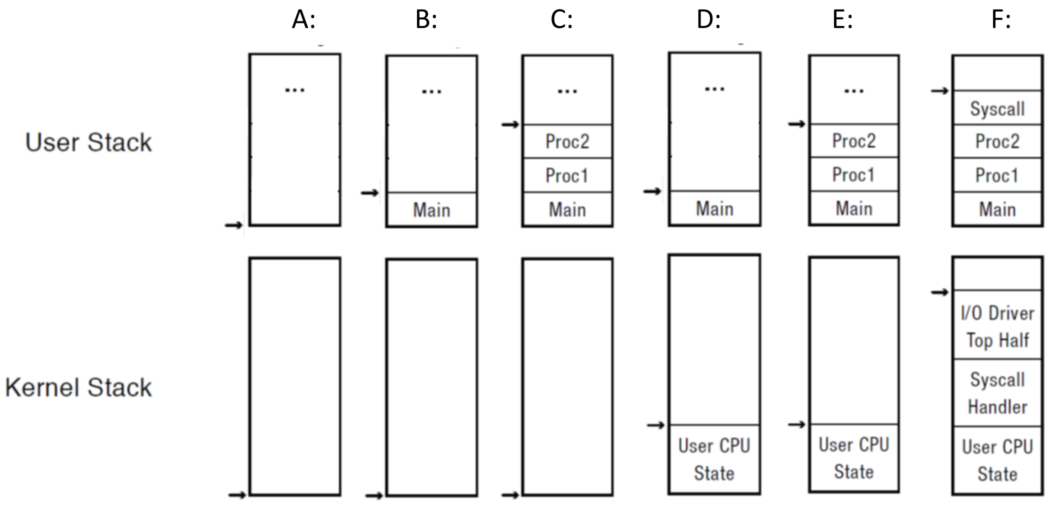
27. T / F An operating system kernel can use internal threads.

28. T / F Each interrupt handler has its own thread control block.

29. T / F A return from interrupt instruction should be a privileged instruction.

30. T / F Threads are more expensive for the operating system kernel to create than processes.

For each description of a thread in questions 31-34, write the letter of the matching stack diagram, A-F. (1 pt. each)



31. ________ Newly created thread.

32. ________ Running thread that is executing inside Proc2().

33. ________ Waiting thread that has made a system call for input/output.

34. ________ Ready thread that will resume executing Proc2() when next dispatched.

35. Consider user-mode updates to a shared counter. The shared counter is initialized to zero.

```
// Global declaration
int shared_counter = 0;

// Thread 1                              // Thread 2
        int local;                               int local;
T1S1:   local = shared_counter;          T2S1:   local = shared_counter;
T1S2:   local = local + 1;               T2S2:   local = local + 1;
T1S3:   shared_counter = local;          T2S3:   shared_counter = local;
```

The sequence { T1S1; T1S2; T1S3; T2S1; T2S2 T2S3 } changes the value of the shared counter to 2. Starting over from an initial value of zero, consider the sequence { T1S1; T2S1; T1S2; T2S2; T1S3; T2S3 }. What is the value of the shared counter after this sequence? (1 pt.)

For each of the following synchronization techniques listed in 36-47, mark whether it is appropriate or not to protect the critical section for a user-mode update to a shared counter as attempted in question 35. (1 pt. each)

36. Yes / No Blocking Bounded Queue (BBQ)
37. Yes / No Condition Variable (CV)
38. Yes / No Disable/enable interrupts
39. Yes / No Fine-grain locking
40. Yes / No Mellor-Crummey Scott (MCS) lock
41. Yes / No Multiprocessor queueing lock
42. Yes / No Optimistic concurrency
43. Yes / No Read-Copy-Update (RCU)
44. Yes / No Readers/Writers Lock (RWLock)
45. Yes / No Spinlock
46. Yes / No Synchronization barrier
47. Yes / No Two-phase locking

48. Take one of the synchronization techniques above that you marked as appropriate and add the appropriate declarations, statements, method calls, etc. to the user-mode update code shown below. (5 pts.)

```
                    // Global declarations, statements, etc.

                        int shared_counter = 0;



    // Thread 1                                  // Thread 2


        int local;                                   int local;


        local = shared_counter;                      local = shared_counter;


        local = local + 1;                           local = local + 1;


        shared_counter = local;                      shared_counter = local;
```

49. With regard to signals and waits, what do we mean when we say that a condition variable is memoryless? (1 pt.)

50. Beside spurious wakeups, why must the CV::wait() operation be called from within a loop? (1 pt.)

Deadlock Prevention / Avoidance / Detection and Recovery. Circle **only one** of P, A, or D&R. (1 pt. each)

51. P / A / D&R Rollback and retry.

52. P / A / D&R Banker's algorithm.

53. P / A / D&R Hierarchical ordering of resource requests.

FIFO / RR / MFQ / SJF-preemptive. Circle ***one or more*** of F, R, M, S, as applies. (2 pts. each)

54. F / R / M / S Is preemptive.

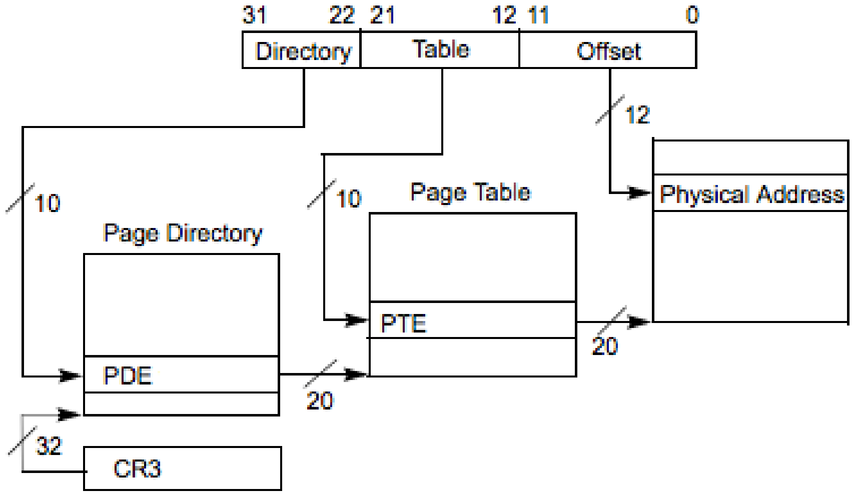
55. F / R / M / S Allows starvation.

56. F / R / M / S Provides best average response time for every possible workload.

57. Define affinity scheduling and identify its advantage. (1 pt.)

58. Define priority aging and identify its advantage. (1 pt.)

Answer questions 59-63 using powers of 2 and a memory byte as the addressable unit.



59. What is the virtual page size in the scheme above? (1 pt.)

60. What is the page frame size in the scheme above? (1 pt.)

61. What is an appropriate superpage size for the scheme above? (1 pt.)

62. For a virtual address of 0x12345678, what is the virtual page number? (1 pt.)

63. Consider a contiguous data structure of 2 MiB. How many pages do you need to store this structure? (1 pt.)

64. What four values or fields would you typically find in a page table entry (PTE) in a scheme such as the one shown on the previous page? (4 pts.)

65. How is the core map used when a page is chosen for replacement? (1 pt.)

66. Explain how copy-on-write is implemented for a paging system. (2 pts.)

67. The time required for a sequence of five reads to random sectors on a disk can take almost five times longer than the time required to read five contiguous sectors. What are the factors involved in disk access that lead to such a disparity? (2 pts.)

Directory Entry / Indexing Structure / Per-Open Data Structure / Process Control Block / Thread Control Block. Circle **only one** of DE, IS, PODS, PCB, or TCB, as applies. (2 pts. each)

68. DE / IS / PODS / PCB / TCB Contains the filename.

69. DE / IS / PODS / PCB / TCB Contains a list of open files.

70. DE / IS / PODS / PCB / TCB Contains the pointer to the current byte or record in a file.

71. DE / IS / PODS / PCB / TCB The data structure that supports a connection-oriented interface for file accesses.

72. Label the following steps that occur in opening an existing file in their proper sequential order, 1-3. (1 pt. each)

____ Initialize the file position pointer in the per-open data structure to the first byte (or record) of the file.

____ Find the directory entry for the named file. Check the access permissions and return an error code if the requested access is not allowed.

____ Create a process-local per-open data structure and record the access permission under which the file was opened and the location of the file's indexing structure.

73. Identify three distinct conventions for indicating the file type of a file. (3 pts.)

74. What are the possible values for an entry in a File Allocation Table (FAT)? (2 pts.)

75. Give at least one reason why the tree structure in an FFS inode is asymmetric. (2 pts.)

76. How is the NTFS indexing structure more flexible than an FFS inode? (2 pts.)