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Midterm 2 Name _____

Directions: This is CSCI-152 Midterm 2. It is a closed book and closed notes examination that consists of three parts and is worth 150 points. Write your answers on the test pages as appropriate. Wherever possible show your work so partial credit can be assigned. You have one hour and fifteen minutes to complete the exam.

Section 1	True/False Questions 1-10	30 Points	_____
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Section 2	Multiple Choice Questions 11-30	60 Points	_____
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Section 3	Problems Questions 31-36	60 Points	_____
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Total		150 Points	_____
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		Letter Grade	_____
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Section 1: True/False (Worth 30 Points)

1. _____ Belady's Anomaly is a problem that is present with all page replacement algorithms, but it is more of a problem with First-in-First-Out (FIFO).
2. _____ Average turnaround time tends to get worse as the length of the time quantum decreases. This degradation is caused only by time lost because of more context switches.
3. _____ A blocked process that is activated by monitor foo's signal operator will always be the next process to enter monitor foo.
4. _____ In real-time systems, priority inversion occurs when a low priority process has to wait until a high priority process finishes.
5. _____ Test-and-set is a solution to the mutual exclusion problem that is normally implemented at the hardware level. Sometimes a swap routine is used instead.
6. _____ Requiring that processes take turns to coordinate a critical section violates (i.e., does not satisfy) the 'progress' condition.
7. _____ The book states that hit rates of between 80 and 98 percent can be achieved with between 16 and 32 associative registers.
8. _____ The data structure for monitor condition variables consists of a queue origin and an integer location to store the condition variable value.
9. _____ External fragmentation is wasted space located between two different partitions in memory.
10. _____ Most algorithms that prevent deadlock by denying hold and wait provide very good utilization of resources.

Section 2 Multiple Choice (Worth 60 Points)

MULTIPLE CHOICE: 20 questions (3 Points Each). Select the best possible response and record your answer by circling the appropriate letter. CIRCLE ONLY ONE ANSWER FOR EACH QUESTION.

11. A system that requests all of its non-sharable resources in advance of execution is preventing deadlock by denying:
- mutual exclusion.
 - no-preemption.
 - hold and wait.
 - circular wait.
12. If a system is allowed to enter deadlock and recovers from deadlock by killing all processes involved in the deadlock, after the processes have been killed:
- the deadlock detection algorithm should be run again.
 - the deadlock is guaranteed to be cleared and no process must be restarted.
 - the deadlock is guaranteed to be cleared and all processes must be restarted.
 - it is certain that the deadlock has NOT been cleared.
13. An unsafe state in Deadlock Avoidance means:
- there is no way for all of the processes being considered to finish.
 - at least one process is holding one resource and it is waiting for another resource.
 - there is no way for all of the processes being considered to finish if they all hold on to their claim until termination.
 - the processes are in deadlock.
14. The algorithm for placing segments in memory that you would expect to execute fastest and with good utilization of memory is:
- First Fit.
 - Worst Fit.
 - Best Fit.
 - Circular First Fit.

15. Which of the following stores the contents of the CPU registers in the Process Control Block (PCB) of one process and loads the PCB contents of another Process into the CPU registers.
- First-Level Interrupt Handler.
 - Scheduler.
 - Resource Allocator.
 - Dispatcher.
16. In segmentation, a logical address consists of:
- an offset added to a base register.
 - a segment number and an offset.
 - segment table contents concatenated with an offset.
 - a segment table base register and segment table length register.
17. The following code can:

```
program main;
var flag:array[0..1] of boolean;
procedure user(i);
  var j: integer;
  begin (* user *)
    j := (i + 1) mod 2;
    while flag[j] = do noop;
    flag[i] := true;
      critical section;
    flag[i] := false;
  end;
begin (* main *)
  flag[0] := false;
  flag[1] := false;
  cobegin
    user(0);
    user(1);
  coend;
end.
```

- suffer from starvation.
- enter deadlock.
- violate mutual exclusion.
- does not satisfy progress.

18. In a paged system, a physical address consists of the:
- contents of the base register added to the displacement.
 - page number and a displacement.
 - page frame number concatenated with a displacement.
 - displacement added to a register containing the page frame number.
19. Counting semaphores can take on the values of:
- any positive integer.
 - any positive or negative integer.
 - any real number.
 - 0 and 1 only.
20. A cycle in a process/resource graph indicates:
- processes involved in the cycle are in deadlock.
 - all processes in the graph are in deadlock.
 - processes involved in the cycle could be involved in deadlock but, then again they may not be.
 - it is certain that no processes in the graph are in deadlock.
21. You would expect that a semaphore used to protect a critical section (section requiring exclusive access to code) would be initialized to:
- 0.
 - 1.
 - 2.
 - 3.
22. Given a page size of 512, what page and offset is the logical address 153654 located on?
- page 300, offset 53.
 - page 300, offset 54.
 - page 299, offset 54.
 - page 53, offset 300.
23. Demand paging is the loading of a page in memory:
- only when an address on that page is accessed.
 - in advance of any address on that page being accessed.
 - well before an address on that page is accessed.
 - all of the above.

24. To verify the validity of the segment number used in a CPU address and locate the segment table in memory, the following is used:
- STBR and STLR.
 - PTBR and PTLR.
 - base and limit in the segment table.
 - frame in the page table
25. The segment table for segment 31 contains a limit of 3499 and a base of 3500. What is the physical address assigned to the logical address with a displacement of 3126?
- 3126.
 - 3526.
 - 6626.
 - error.
26. Execution of a waiting list semaphore signal operator:
- frees a process from the monitor entry queue if one is blocked; otherwise it is ignored.
 - frees a process from the condition variable queue if one is blocked; otherwise it is ignored.
 - frees a process from the semaphore variable queue if one is blocked; otherwise it increments the semaphore variable value by one.
 - both a. and b. above are correct.
27. Which of the following are important when considerations when coordinating critical sections:
- ensuring the bounded wait condition.
 - ensuring progress.
 - guaranteeing mutual exclusion.
 - all of the above.
28. Which of the following are advantages of virtual memory systems?
- The program size is not constrained by the physical size of memory.
 - More users can be in memory and therefore more can run at one time.
 - Less input/output may be required.
 - All of the above.

29. Given the following monitor code segment:

```
monitor coord;
var busy: boolean;
    block_process: condition;
    procedure get_resource;
        begin
            if busy then wait(block_process);
            busy := true;
            signal(block_process);
        end;
    ...
begin
    busy := false;
end;
```

If process 1 is interrupted at the following statement before it is blocked on the condition variable queue block_process:

```
    if busy then wait(block_process);
```

and process 2 makes a call to the `get_resource` monitor procedure, process 2 will:

- a. block on the monitor entry queue.
 - b. block on the `block_process` condition variable queue.
 - c. complete the `get_resource` procedure code without blocking.
 - d. all of the above.
30. Using an inverted page table, the page frame number is found by:
- a. loading it from memory at the page table entry for that page (just like the frame is found in a normal page table).
 - b. deriving it from the valid/invalid bit.
 - c. adding the PTBR to the PTLR.
 - d. using the page table array subscript where that page and the user-id for that page is found.

Section 3: Problems (Worth 60 Points)

Problems: Write your answer to the following questions in the space provided. Show all work so partial credit can be assigned.

31. (10 Points) consider the following table where A, B, C, D, and E are processes and X, Y, and Z are resources. The system is currently in a safe state. Using deadlock avoidance, would a request by process E for (2 1 0) be granted? Justify your answer with a complete explanation.

	<u>Allocation</u>	<u>Need</u>	<u>Available</u>
	X Y Z	X Y Z	X Y Z
A	3 0 2	6 0 0	2 2 0
B	0 0 2	4 3 1	
C	0 3 0	7 2 3	
D	0 0 2	4 3 1	
E	3 0 2	2 1 0	

32. (10 Points) Consider the following memory reference string:

5W, 3W, 4R, 2R, 1W, 5R, 3W, 3R, 4R, 1R, 3R, 3R, 2W, 1R

where each number is an access to a page and the letter indicates whether that page was only read from during that access (R) or written to during that access (W).

Consider the following page replacement algorithm. Four page frames are assigned to the process running this reference string. Each page frame has a reference bit and a dirty bit assigned to it.

REFERENCE BIT

1. All reference bits are set to 0 at process start.
2. Whenever a page is accessed, the reference bit of the page frame where it is stored is set to 1.
3. Immediately following each 4th reference, the reference bits of all page frames are cleared to 0.

DIRTY BIT

Once a dirty bit is set, it stays set so long as the page remains in memory.

The following is the (reference bit, dirty bit) priority for pages staying in memory with the highest priority first: (1,1), (1,0), (0,1), (0,0). Fill in the following page frames showing the references as they occur and then list the total number page faults that have occurred:

5W	3W	4R	2R	1W	5R	3W	3R	4R	1R	3R	3R	2W	1R

Faults = _____

33. Given that processes A, B, and C have:

- one instance of resource X,
- two equally suitable instances of resource Y, and
- one instance of resource Z.

and

- one instance of Y is allocated to B,
- one instance of X is allocated to C,
- one instance of Y is allocated to C,
- C has requested one instance of Z,
- A has requested one instance of X,
- A has requested one instance of Y,
- one instance of Z is allocated to A,

a. (5 Points) Represent the processes as circles and resources as squares and draw a graph that describes the above conditions.

b. (5 Points) Is the system in deadlock?_____ If so, which processes are involved in the deadlock?_____ If not, what order can the processes finish in?_____

34. (10 Points) What are the disadvantages of Deadlock Avoidance?

35. (10 Points) Consider the following formula:

$$\text{EAT} = (1-P) \times \text{MA} + P \times \text{PFT}$$

Where EAT = Effective Access Time
 P = Probability (or frequency rate) of a Page Fault
 MA = Memory Access Time
 PFT = Page Fault Service Time

If MA = 4 nanoseconds, PFT = 100 milliseconds, less than 25 percent degradation due to paging is desired, what is the maximum page fault frequency rate that can be allowed (show your work)?

Maximum Page Fault Frequency Rate = _____

36. List the advantages and disadvantages of SMALL page frames.