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1. (a)
   (i) False. Real-time systems are systems which have stipulated time to return the result, not all timesharing systems fulfill this requirement.
   (ii) True. Disabling interrupts during the critical section makes it impossible for any other process to take over control and ensured that only one process is running the critical session, hence mutual exclusion
   (iii) False. If the size of the quantum is that of the largest CPU burst time among all the processes, then the scheduling would just degenerate to FCFS.
   (iv) False. Deadlock will never occur if there is no cycle.
   (v) True. The system will then execute the routine to handle the interrupt

   (b)
   (i) a)

time	0	1	2	3	4	5	6	7	8	9	10	11	12	13
running process		P0	idle	P1	P1	P1	P1	P1	P0	P0	P2	P2	P3	P3

   b)

time	0	1	2	3	4	5	6	7	8	9	10	11	12	13
running process		P0	idle	P1	P1	P0	P0	P1	P1	P2	P2	P1	P3	P3

   (ii) Turnaround time is the amount of time to execute a process, from time of submission to time of completion. Waiting time is that minus the execution time:
   SJF:

P0	P1	P2	P3
Turnaround: 9-0=8 Waiting: 8-5=3	Turnaround: 7-2=5 Waiting: 5-5=0	Turnaround: 13-4=9 Waiting: 9-4=5	Turnaround: 13-8=5 Waiting: 5-2=3

   Average waiting time = (3+0+5+3)/4=2.75
   RR:

P0	P1	P2	P3
Turnaround: 6-0=8 Waiting: 6-5=1	Turnaround: 11-2=9 Waiting: 9-5=4	Turnaround: 12-4=8 Waiting: 8-4=4	Turnaround: 13-8=5 Waiting: 5-2=3

   Average waiting time = (1+4+4+3)/4=3

   (c)
   (i) -4. Think it in two ways: 4 blocked process and hence the value should be -4. According to the next question ii), after +3 the value is -1 hence previously the value should be -4
   (ii) minimum is -6, if the order is
   Wait Wait Signal Signal Signal Signal Signal
   After the second wait, the value is at the minimum: -6
   Maximum is 1 if the order of execution is

Signal Signal Signal Signal Signal Wait Wait
After the fifth signal, the value is at the maximum: 1

(iii) 2. If the two processes executed Wait(S) successfully finishes, there would be two Signal(S) calls. If the 4 waiting process finishes, there would be 4 Signal(S) calls. In total there are 6 Signal calls which increased the S from -4 by 6 to 2.

2. (a)

(i) False. It is to protect from illegal hardware interacting instruction, e.g. I/O
(ii) False. Register values are loaded from the register to the PCB of P0
(iii) False. It may be executing I/O and the processor are idle
(iv) True.
(v) True.

(b)

(i) Process 0 could finish if B is allocated to it. After it finishes, the available resource would be 2, 2, x+1
Process 2 could finish if 2*A and C is allocated to it. After it finishes, the available resource would be 3, 3, x+2
Process 1 could finish if 2*A, B and 2*C is allocated to it. After it finishes, the available resource would be 4, 4, x+2
Process 3 could finish if 4*A and 2*B and 2*C is allocated to it. After it finishes, the available resource would be 5, 5, x+3
Thus, the minimum value for x is 0

(ii) No. If the request was to granted. There would be zero A and zero B. There is no process that is guaranteed to return which only need more resource of C

(c)

i)
1: Wait(A)
2: Signal(A), Wait(O)
3: Signal(O)
4: Signal(O), Wait(A)
5: Signal(A)
No deadlock because there is no nesting of semaphores being acquired
ii) No, if there are no orange, she would still pick up the apple. A better strategy would be only pick Apple and two oranges if there are both present

3.

(a)

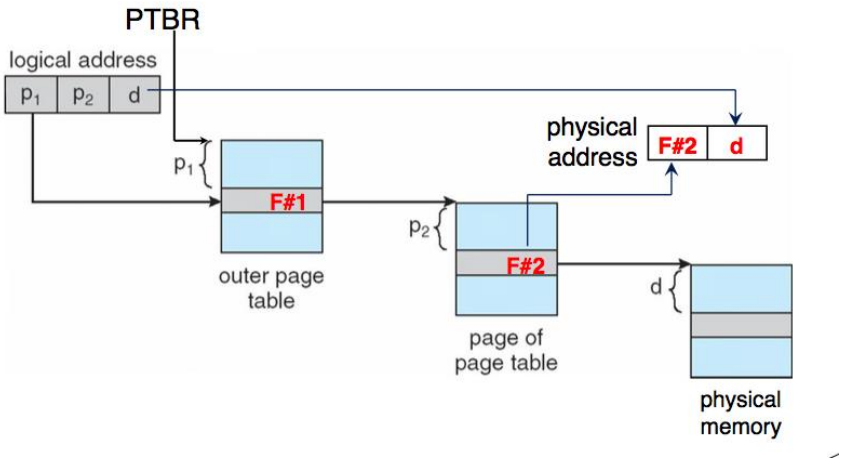
(i) False. Segmentation suffers from external fragmentation.
(ii) False. TLB is to reduce effective access time.
(iii) False. For demand paging, address binding must be done at execution time.
(iv) False. In some special case increase of page frame could increase page fault – Belady's anomaly in the case of FCFS
(v) True.

(b)

(i) Page size is 8192 bytes = 2^{13} bytes (13bits of offset)

(ii) 9bits in the outer level, hence 2^9=512 entries

(iii)



(iv) $2^{(10+9)}$ =2^{19}= 524288 entries

(c) Use of array could be faster compared to the use of linked-lists. Since arrays usually allocate a block of memory when initialized, the memory addresses are usually continuous, hence the physical memory it accesses tend to reside in the same page. On the contrary, the linked list tends to allocate the memory on demand. Thus there is no guarantee that the memory it accessed is located in the same page, leading to higher page fault.

4. (a)

(i) True. Like on Windows & Mac systems due to links.

(ii) False, only the owner and the group can read the file.

(iii) False. Buffering is used to store data temporarily stored in the memory when they are transferred between devices with different transfer sizes.

(iv) False. A program reading a contiguously allocated file will generate requests that are close together.

(v) True. For a better response time.

(vi) False. Mirror of strips (0 + 1) is not as reliable as strips of mirrors (1 + 0) because if one of the disks in both the mirrored disks fails, we will be unable to extract the complete file from either of the mirrors which is not the case for 1 + 0.

(b)

(i) Two, as you need to read two i-nodes to locate that directory

(ii) 10+11+12+indirect + 13 -> 5 disk reads

(c)

(i) SSTF: sequence: 150 180 190 60 30 -> Travel = 10 + 30 + 10 + 130 + 30 = 210

SCAN sequence: 180 190 199 150 60 30 -> Travel = 20 + 10 + 9 + 49 + 90 + 30 = 208

SCAN has less movement

ii) SCAN avoid starvation