Please do not read the questions until your class starts, and do not share this document.

There will be no marks for answering these questions correctly. On the other hand, if we find that you knew the questions and/or the answers before your class you will receive zero participation marks for that tutorial.

In all questions below, you need to choose **one answer**.

Q1. Which of the following steps are performed during page fault processing? Select an answer that contains most steps, lists the steps in correct order, and does not contain wrong steps.

A. The OS validates the memory access, aborting the program if needed. If the access was valid, a free memory frame is identified  
B. The OS puts the calling process to sleep (into a waiting queue), and brings the missing page into memory  
C. The OS validates the memory access, restarting the program if needed. If the access was valid, a free frame is identified, the page is brought into main memory and the instruction is restarted  
D. The OS puts the calling process to sleep (into a waiting queue), and resumes the process when a free frame becomes available  
E. The OS validates the memory access, aborting the program if needed. If the access was valid, the page is brought into main memory and the instruction is restarted

Q2. Consider a page-reference string for a system with m frames (initially all empty). The page-reference string has length p, and contains n distinct page numbers. Answer these questions for any page-replacement algorithm:  
- What is a lower bound on the number of page faults?  
- What is an upper bound on the number of page faults?

A. n and m  
B. m and p  
C. n and p  
D. p and n  
E. 0 and m

Q3. Which of the following statements is INCORRECT?

A. Optimal algorithm cannot be used in practice  
B. Optimal algorithm does not suffer from Belady's anomaly  
C. LRU algorithm does not suffer from Belady's anomaly  
D. Second-chance algorithm is an approximation of LRU algorithm  
E. Some of the above are incorrect

Q4. Identify specialized hardware support commonly used for demand paging. Select an answer that contains most correct items, and does not contain wrong items

(i) Consulting the page table whether the corresponding page is resident  
(ii) Stack register used for stack segment of virtual memory  
(iii) A TLB that could serve as a cache and improve the performance of the lookup operation  
(iv) Ability to restart a process

A. (i) (iii)  
B. (i)  
C. (i) (ii)  
D. (iii) (iv)  
E. (i) (ii) (iii)

Q5. Consider the following page reference string:  
1, 2, 3, 4, 2, 1

How many page faults would occur for the following replacement algorithms? Assume that all frames are initially empty. Select the correct case below.

A. Number of frames == 3, Algorithm == LRU, page faults num == 4  
B. Number of frames == 3, Algorithm == LRU, page faults num == 6  
C. Number of frames == 2, Algorithm == LRU, page faults num == 5  
D. Number of frames == 2, Algorithm == Optimal, page faults num == 5  
E. Number of frames == 2, Algorithm == Optimal, page faults num == 4

Q6. Consider a demand-paged computer system where the degree of multiprogramming is currently set at four. The system was recently measured to determine utilization of the CPU and the paging disk. Three alternative results are shown below. Select the best interpretation for each result.  
(i) CPU utilization 13%; disk utilization 97%  
(ii) CPU utilization 87%; disk utilization 3%  
(iii) CPU utilization 13%; disk utilization 3%

A. (i) thrashing, degree of multiprogramming should be decreased (ii) healthy, degree of multiprogramming can be increased, (iii) thrashing, degree of multiprogramming should be increased  
B. (i) healthy, degree of multiprogramming can be increased, (ii) healthy, degree of multiprogramming can be increased, (iii) thrashing, degree of multiprogramming should be decreased  
C. (i) thrashing, degree of multiprogramming should be decreased (ii) healthy, degree of multiprogramming can be increased, (iii) healthy, degree of multiprogramming can be increased  
D. in all cases degree of multiprogramming can be increased  
E. in all cases degree of multiprogramming should be decreased