Assignment 2

Instructions

1. **Due Date: Monday, November 20th, 2023**. Submit your answers to Canvas.
2. Before you begin, please take the time to review the course policy on academic integrity at: https://www.cityu.edu.hk/provost/academic_honesty/rules_on_academic_honesty.htm. Please write your own solution. All submissions will be scanned by anti-plagiarism software.

Questions

Please use the answer sheet provided to write all your answers.

1. Consider the traffic deadlock depicted in Figure 1.
   a. Show that the four necessary conditions for deadlock indeed hold in this example.
   b. State a simple rule for avoiding deadlocks in this system.

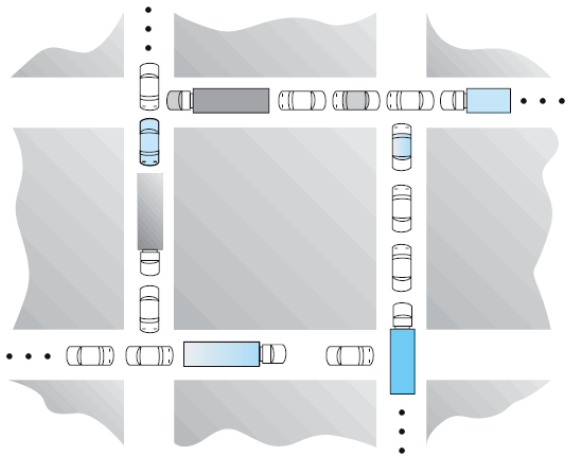

Figure 1 Traffic deadlock.

2. Consider the following snapshot of a system

	Allocation					Max					Available			
	A	B	C	D		A	B	C	D		A	B	C	D
P0	4	0	0	3		4	0	1	3		3	5	3	1
P1	2	0	0	0		2	8	5	0					
P2	1	2	2	5		2	2	3	6					
P3	0	5	2	2		0	6	5	2					
P4	0	0	1	3		0	3	6	6					

Answer the following questions using the Banker's algorithm.

a) How many resources of type A, B, C, and D are there?
b) Is the system in a safe state? If so, list a safe sequence. If not, explain why?
c) If a request from process P1 arrives for additional resources of (0,6,4,0), can the system grant the request immediately? Explain and show the detailed steps.

3. Consider a paging system with the page table stored in memory.

a) If a memory reference takes 260 nanoseconds, how long does a paged memory reference take?

b) If we add TLB, 80 percent of all page-table references are found in the TLB, while accessing TLB takes 15 nanoseconds. What is the effective memory reference time?

4. Considering a 16 bits system, use a linear translate page table with the following assumptions:

- The page size is 32 bytes;
- The virtual address space for the process is 512 pages or 16KB;
- Physical Memory consists of 128 pages.
- Every entry in the page table has one extra VALID bit
- Page entry per page is 32 PTEs.

a) Please design this linear translate page table in detail, including the format of the PTE and virtual/physical address and the meaning of each part.
b) Is this page table effective? If not, how to improve it? Describe the improved page table in detail.

5. Given the following reference string:

1, 3, 2, 4, 4, 2, 5, 1, 6, 7, 8, 7, 8, 9, 7, 8, 9, 4, 5, 4, 5, 3

Run (a) the Optimal page replacement algorithm, (b) the LRU page replacement algorithm on the above reference string with a 4 free frame physical memory and computing the number of page faults on that string, respectively.