Ryerson University
Department of Electrical and Computer Engineering
ELE648: Real-time Operating System
Final Examination 2002

Total Time Allowed: 2 Hours **Maximum Marks: 85**

General Instructions

a) Total time allowed is **2 hours**.
b) The examination has **2** pages and **6** questions. Answer all the questions.
c) To earn full credit, your answer must be concise and to the point.
d) Some questions contain special instructions. Please ensure that you read them carefully.
e) All questions are not of the same difficulty and value. Consider this when allocating time for their solution.
f) Estimated time for each question is equivalent to the marks assigned to it.

---

1. (a) Five processes are competing for resources R0, R1, R2 and R3 where (R0, R1, R2, R3) = (6, 4, 4, 2). The maximum claim for these processes is given in Table Q1a. Resource allocator is considering allocating initial resources to these processes according to Table Q1b.
Is this initial allocation leads to a safe state? Why or why not?

MARKS: (14)

Process	R0	R1	R2	R3
P0	3	2	1	1
P1	1	2	0	2
P2	1	1	2	0
P3	3	2	1	0
P4	2	1	0	1

Table Q1a: Maximum Resource Claim

Process	R0	R1	R2	R3
P0	2	0	1	1
P1	1	1	0	0
P2	1	1	0	0
P3	1	0	1	0
P4	0	1	0	1

Table Q1b: Initial Allocation

(b) Why deadlock cannot happen in two-phase locking.
Two-phase locking can lead to starvation. How can it happen?

MARKS: (4)

2. A virtual memory based computer system is managed by a paging system. It has a 24-bit virtual address, page size of 4096 bytes and 4 bytes per page table entry.
(a) Determine the number of pages in the virtual address space.
(b) Suppose we have a 4Mbyte program such that the entire program and the page table is in main memory. How much memory including its page table does the program use?

MARKS: (3+4)

3. (a) When a TLB entry is replaced, it is just overwritten and is not written back to the page table. However, when a page is replaced, sometimes it must be written back to disk before the page frame can be reused.
   i) Explain why these two situations are different. **MARKS: (6)**
   ii) Are there situations where a TLB entry would have to be written back to the page table?
   iii) Are there situations where a TLB entry would be different from the page table entry in page table?

   (b) An operating system is managing a memory system with dynamic partitioning. The memory system consists of the following holes from its start: 10KB, 4KB, 20KB, 18KB, 7KB, 9KB, 12KB and 15KB. Determine the holes taken for the successive memory segment request of: 12KB, 10KB and 8KB by using the following memory placement strategies:
   i) First fit
   ii) Best fit
   iii) Worst fit **MARKS: (9)**

4. A process consists of 7 pages and it is being executed by a virtual memory based computer system that allows a resident set of 4 frames for each process. Details of the resident pages in terms of their time of loading, time last accessed, and R and M bits are given below.

Frame #	Virtual Page #	Time Loaded	Time Last Referred	R-Bit	M-bit
10	1	110	280	1	0
21	3	230	270	0	0
22	2	140	265	0	0
23	4	126	285	1	1

A page reference stream of (6 4 5 1 3 4 1 3 5 7 5) is generated by the process execution. Implement LRU and FIFO page replacement policies for the above page stream to determine the most economical page replacement policy.

MARKS: (14)

5. Two processes, p1 and p2 have been designed so that p2 prints a stream of bytes produced by p1. The processes need to be synchronized by using monitor mechanism to provide mutual exclusion. Assume that a finite size shared buffer is available to both processes.
   (a) Write a skeleton code for processes p1 and p2 to illustrate how they synchronize with one another by using the monitor mechanism.
   (b) Identify the procedures and variables that must be included in the monitor.
   (c) Write the skeleton code for monitor procedures. **MARKS: (12)**

6. (a) Round robin is the most widely used technique for short-term scheduling. Implement a standard round robin scheduling for the following processes by showing a time-line. Assume that time quantum, q = 20.

MARKS: (14)

Process #	Service Time	Arrival Time
0	80	0
1	40	15
2	20	15
3	40	85
4	60	100

   (b) A potential problem with threads is that all threads get an equal chance to be run and so a process can get more CPU time by creating more threads. Suppose we want to treat processes equally and give equal chance to each process no matter how many threads it had. Describe a technique for doing this.

MARKS: (5)