Roll No.................

Operating System- MTL458
Major Examination
Date: 24-11-16, Time: 2 hour, Total Marks: 40

- **Write your Roll No. on the top immediately on receipt of the question paper.**
- **Attempt ALL questions along with any *two parts* from each question. All questions carry equal marks.**

1. (a) Suppose the page table for the process currently executing on the processor looks like the following. All numbers are decimal, everything is numbered starting from zero, and all addresses are memory byte addresses. The page size is 1024 bytes.

Virtual page number	Valid bit	Reference bit	Modify bit	Page frame number
0	1	1	0	4
1	1	1	1	7
2	0	0	0	-
3	1	0	0	2
4	0	0	0	-
5	1	0	1	0

(a.1) Describe exactly how, in general, a virtual address generated by the CPU is translated into a physical main memory address.

(a.2) What physical address, if any, would each of the following virtual addresses correspond to?

(i) 1052, (ii) 2221, (iii) 5499

(b) Assuming a page size of 4 Kbytes and that a page table entry takes 4 bytes, how many levels of page tables would be required to map a 64-bit address space, if the top level page table fits into a single page?

(c) Consider the following page reference strings: 1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6. How many page faults would occur for the LRU replacement algorithm, assuming four frames?

2. (a) Consider a system with a total of 150 units of memory, allocated to three processes as shown:

Process	Max	Hold
1	70	45
2	60	40
3	60	15

Apply the banker's algorithm to determine whether it would be safe to grant each of the following requests. If yes, indicate a sequence of terminations that could be guaranteed possible. If no, show the reduction of the resulting allocation table.

(a.1) A fourth process arrives, with a maximum memory need of 60 and an initial need of 25 units.

(a.2) A fourth process arrives, with a maximum memory need of 60 and an initial need of 35 units.

(b) N processes share M resource units that can be reserved and released only one at a time. The maximum need of each process does not exceed M, and the sum of all maximum needs is less than M + N. Show that a deadlock can not occur.

(c) Suppose that there are two types of philosophers. One type always picks up his left fork first (a "lefty"), and the other type always picks up his right fork first (a "righty"). Using semaphore, define both type of philosophers' behavior.

3. (a) Consider a concurrent program with two processes, p and q, defined as follows. A, B, C, D, and E are arbitrary atomic (indivisible) statements. Assume that the main program (not shown) does a **parbegin** of the two processes.

Void p()	void q()
{ A; B; C;}	{ D; E;}

Show all the possible interleavings of the execution of the preceding two processes (show this by giving execution "traces" in terms of the atomic statements).

(b) Prove the correctness of Peterson's algorithm for mutual exclusion and progress of some processes requiring access to its critical section.

(c) Provide the algorithms for producer and consumer processes in bounded buffer problem and show that they may not function correctly when executed concurrently.

4. (a) Prove that, among nonpreemptive scheduling algorithm, SPN (shortest process next) provides the minimum average waiting time for a batch of jobs that arrive at the same time. Assume that the scheduler must always execute a task if one is available.

(b) Consider the set of any four processes, with the length of the CPU burst (8, 4, 9, 5) and arrival time (0, 1, 2, 3) given in milliseconds. Draw a Gantt chart that illustrate the execution of these processes using shortest-remaining-time-first scheduling. Also, calculate turnaround time of each process.

(c) Suggest a criteria for comparing CPU-scheduling algorithms.