INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
Computer Science and Engineering
Course: CS341 (Operating System), End-Semester Exam

Date: 21st Nov 2014 Timing: 1.00PM-4.00PM Full Marks: 60

1. [Lock, Monitor and Deadlock: 5 Lectures (=26%)] 16 Marks [3+2+2+3+6]

a) [**3 Marks**] What are the possible ways to handle deadlock in Dining-Philosophers problem (Five philosophers sit at a round table with bowls of spaghetti. Forks are placed between each pair of adjacent philosophers). [May be using lock/monitor/semaphore you can handle this, but you need to say : how to break at least one of the deadlock conditions]

b) [**2 Marks**] Show that, if both the wait() and signal() semaphore operations are not executed atomically, then mutual exclusion may be violated.

c) [**2 Marks**] Write a monitor that implements a counting semaphore for a resource with 25 instances. The monitor should have three public functions: init_ctr(), wait_ctr() and signal_ctr();

d) [**3 Marks**] A system has 10 processes and three identical resources. Each process needs a maximum of two resources to complete. Is deadlock possible? Explain your answer. [*No credit for answer YES/ NO, justification carry marks*]

e) [**6 Marks:2+2+1+1**] Draw Resource Allocation Graph (RAG) for the system described in the following Table. Annotate edges (with X symbol) for reduction of the resource allocation graph. Is system in a safe or unsafe state? Is the system deadlocked? [*You will not get any credit of last two questions unless you draw the RAG correctly and reduce*]

	Current Allocation			Outstanding Allocation			Maximum Allocation			Resource Available		
	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3
P1	0	1	0	0	0	0	0	1	0	0	2	0
P2	2	0	0	1	0	0	3	0	1			
P3	1	2	0	0	0	1	2	5	2			
P4	0	1	1	0	0	0	1	4	2			
P5	0	0	1	0	0	1	2	0	1			

2. [Main Memory and Virtual Memory: 8 Lectures (=42%)] 25Marks [4+2+3+3+4+6+5]

a) [**2+2 Marks**] What is the cause of thrashing? How can you model thrashing based on working set of processes?

b) [**2 Marks**] Prove that optimal page replacement algorithm will not suffer Belady's anomalies.

c) [**3 Marks**] Segmentation is same as paging but uses variable sized pages. Define LRU segment replacement algorithm for demand segmentation.

d) [**1.5+1.5 Marks**] What kind of hardware support OS need to implement TLB? Is it possible to increase TLB size of a computer by upgrading or updating the OS?

e) [**2+2 Marks**] What should be structure of TLB in global frame allocation and local frame allocation? Suggest some efficient approach to organize TLB in non-uniform Memory Access (NUMA) multiprocessor.

f) [**6 Marks**] Suppose you have modified the demand paging fetch policy to a new one, where you pre-fetch the next logical page when access to the current logical page. Calculate number of page fault occurs in executing the following program, assuming page size=**400byte**, number of frame=**10**, page transfer time **25ns**, statement inside the loop takes **1ns** to execute, and size of integer is 4byte.

```
void main () {
     int A[100000], int B[100000], int C[100000];
     for(i=0;i<100000;i++)
          A[i]=B[i]+C[i];
}
```

g) [**5 Marks**] Given the average size of a process is ***p***, the page size *s* and the size of a page table entry is ***e byte***, what page size minimizes wasted space due to internal fragmentation and page table.

3. [Storage, File System and I/O device driver : 6 Lectures (=31%)] 19 Marks [2+3+4+5+5]

a) [**2 Marks**] What are the differences between logical partitioning and physical partitioning of disk?

b) [**3 Marks=1+2**] As compared to non-RAID system, which RAID level offer best performance in term of bandwidth and capacity? Explain how that RAID level provides the best performance.

c) [**4 Marks**] Suppose a file F of size 16KB is shared by 100 processes, each process read the entire F 10 times sequentially, disk uses linked allocation policy to store both Inode and data of the file with block size 512byte. Calculate the number of disk block access related to access the file F in executing all the 100 processes. (Write all the assumptions if you are assuming at the time of calculation)

d) [**5 Marks= 2+1+1+1**] Write general structure of
   i. I/O hardware and Timer.
   ii. A Linux kernel module.
   iii. Linux/Unix device driver architecture.
   iv. A character device driver

e) [**Marks=2+1.5+1.5**] In Linux OS, file system uses Inode data structure to store the attribute of file.
   i. What is difference between Inode Table and File Allocation Table?
   ii. Where Inode of a file get stored in the disk? Where the Inode Table get stored in the disk? Where the FAT get stored in the disk?
   iii. How can you design a fault tolerant Inode table and FAT of a file system? Give an example of such file system.