Assignment 6
Deadlocks and Virtual Memory Management
CSCI 5103, Fall 2016
Due November 15, 2016

This assignment must be done individually.

Problem 1 : (15 points) Consider a system with consisting of *m* resources of the same type being shared by *n* processes. Prove that the system is deadlock free if:

1. Need(i) > 0 for *i* = 1, 2, 3, …, n, and
2. The sum of all maximum needs is less than *m+n*.

Problem 2 : (15 points) We can obtain the banker's algorithm for a single resource type from the general banker's algorithm simply by reducing the dimensionality of the various arrays by 1. Show through an example that the multiple-resource-type banker's algorithm cannot be implemented by individual application of the single-resource-type scheme to each resource type.

Problem 3: (15 points) A system has four processes and five allocatable resources. The current allocation and maximum needs are as follows;

	Allocated	*Maximum*	*Available*
Process A	1 0 2 1 1	1 1 2 1 3	0 0 x 1 2
Process B	2 0 1 1 0	2 2 2 1 0	
Process C	1 1 0 1 0	2 1 3 1 0	
Process D	1 1 1 1 0	1 1 2 2 1	

What is the smallest value of *x* for which this is a safe state?

Problem 4: (20 points) Consider the two-dimensional array A:

```
int A[][] = new int [100][100];
```

where A[0][0] is at location 200, in a paged system with pages of size 200. A small process is in page 0 (locations 0 to 199) for manipulating the matrix; thus, every instruction fetch will be from page 0.
For three page frames, how many page faults are generated by the following array-initialization loops, using LRU replacement, and assuming page frame 1 has the process in it, and the other two are initially empty:

```
for (int j = 0; j < 100; j++)
        for (int i = 0; i < 100; i++)
                A[i][j] = 0;

for (int i = 0; i < 100; i++)
        for (int j = 0; j < 100; j++)
                A[i][j] = 0;
```

Problem 5: (15 points) A computer has four page-frames. The time of loading, time of last access, and the *R* and *M* bits for each page are as shown below (the times are in clock ticks).

Page	Load time	Access time	R	M
0	126	280	1	0
1	230	265	0	1
2	140	270	0	0
3	110	285	1	1

(a) Which page will NRU replace?
(b) Which page will LRU replace?
(c) Which page will second chance replace?
(d) Which page will FIFO replace?

Problem 6: (10 points) Suppose that a machine has 38-bit virtual addresses and 32-bit physical addresses.

(a) What is the main advantage of a multilevel page table over a single-level one?

(b) With a two-level page table, 16-KB pages and 4-byt entries, how many bits should be allocated for the top-level page table field and how many for the second-level page table field? Explain.

Problem 7: **(10 points)** A small computer has 4 page frames. At the first clock tick, the *R* bits are 0111 (page 0 is 0 and the others are 1). At subsequent clock ticks, the values are 1011, 1000, 1100, 0001, 0010, 1010, and 0100. If the aging algorithm is used with an 8-bit counter, give the values of the four counters after the last tick.

If a page-fault occurs after the 8^{th} clock tick, which page will be evicted?