

There are a possible 86 Points. Do all problems. Be specific and concise in all answers. You have 2 Hours. Use ONLY the space provide on the page for each answer. Your answers are either right or wrong... be careful in your computations!

(1) 25 Points

Assume we have the following three resource classes with the given units in each class:

RC1 has 8 units  
RC2 has 6 units  
RC3 has 4 units

Assume processes 1, 2, 3 and 4 have the following maximum **claim** on the resources:

	Units of RC1	Units of RC2	Units of RC3
Process1:	7	2	0
Process2:	0	4	2
Process3:	3	0	3
Process4:	5	4	1

Assume processes 1, 2, 3, and 4 **hold** the following resources in each resource class:

	Units of RC1	Units of RC2	Units of RC3
Process1:	3	0	0
Process2:	0	3	1
Process3:	3	0	1
Process4:	2	2	1

Is the system state implied by the above a “safe” one?

If so, in what sequence will the processes finish?

If not, identify each process that cannot complete and its problematic resource class.

(2) 40 Points

Memory		Changed Values
Loc	Value	
0	02440	
	12031	
	14090	
	12111	
	08010	
5	09100	
	10101	
	01110	
	05050	
	06160	
10	06011	
	05021	
	07031	
	00040	
	02051	
15	10061	
	11071	
	08081	
	13091	
	04101	
20	01111	
	03121	
	09131	
	12141	
	12120	
25	13311	
	05060	
	04100	
	10101	
	13031	
30	00011	
	04020	
	10011	
	04031	
	04011	
35	13000	
	12001	
	13010	
	10041	
	08010	
40	10021	
	10031	
	08020	
	04001	
	13031	
45	14131	
	.....	.....

PMT Mask: VWXYZ (5-digits)

VW => Frame Number  
 XY => File Address  
 Z => Present (1) / Absent (0) digit

File Address is always valid; Frame Number is only valid if Z = 1

MBT Mask: ABCDE (5 Digits)

AB => Job Number  
 CD => Page Number  
 E => Reference digit (0/1)

MBT starts at memory location 30, length 14

PMTAR:     Addr   Length  
               18     4

Page size is 4K, memory is word addressable,  
 PMT and MBT entries are word addressable

LRU Approximation pointer currently points to page frame 10  
 (the 11<sup>th</sup> entry) in the MBT

Job 4 is currently executing and references compiled address 10192

**Update PMT and MBT accordingly**

Job 10 references virtual address <0, 2594>

The PMT for Job 10 is at memory location 13 and has a length of 5

**Update PMT and MBT accordingly**

Place the tightest bounds on the compiled size of Job 10

<=   **Size of Job 10**    <=

(3) 21 Points

Based on the following initial shared variable and semaphore values,

```
K :           Semaphore <--- 0;
F, G, H, J :  Semaphore <--- 1;
L :           Semaphore <--- 3;
E :           Semaphore <--- 5;
count :       Integer   <--- 0;
```

Consider the following 4 process code segments:

<u>Process A</u>	<u>Process B</u>	<u>Process C</u>	<u>Process D</u>
	P(G)		
	count := count + 1		
P(K)	<b>if</b> count = 1 <b>then</b>		
V(J)	P(H)	P(F)	P(L)
P(E)	V(G)	P(E)	P(J)
<CS>	<CS>	<CS>	<CS>
V(E)	V(K)	V(E)	V(F)
	P(G)		V(L)
	count := count - 1		
	<b>if</b> count = 0 <b>then</b>		
	V(H)		
	V(G)		

(3) Continued

Using the above set of code segments and assuming that there are  $W$  A's,  $X$  B's,  $Y$  C's and  $Z$  D's (where  $W, X, Y,$  and  $Z$  are all greater than 10), answer the following:

- (a) Does mutual exclusion exist between A and C? \_\_\_\_\_
- (b) Must at least one C process execute its  $\langle CS \rangle$  before any D process can execute its  $\langle CS \rangle$ ? \_\_\_\_\_
- (c) How many B's can execute their respective  $\langle CS \rangle$  concurrently? \_\_\_\_\_
- (d) What is the maximum number of A's that can execute their respective  $\langle CS \rangle$  concurrently? \_\_\_\_\_
- (e) Must at least one B execute its  $\langle CS \rangle$  before an A can execute its  $\langle CS \rangle$ ? \_\_\_\_\_
- (f) Does mutual exclusion exist between B and A? \_\_\_\_\_
- (g) How many D's can execute their respective  $\langle CS \rangle$  concurrently? \_\_\_\_\_