⑤

	A				C			
	A	B	C	D	A	B	C	D
P_0	4	1	0	1	6	1	0	2
P_1	2	1	2	0	4	2	1	1
P_2	0	0	0	0	0	0	1	0
P_3	0	0	0	0	3	1	0	4

As we can see, the problem is that P_1 is "using" 2 instances of C when it can use a maximum of 1. In order to guarantee a request, the first thing that Banker's Algorithm does is to check if $req_i \leq (C-A)_i$ and this is the same as checking $req_i + A_i \leq C_i$

Imagine that P_1 is allocating 1 instance of C and then it requests (0, 0, 1, 0) for example. That request is going to be added to AP_1 and then the question is: Is this addition less or equal than CP_1?

Obviously not, because in this addition we have 2 instances of C while the maximum to be used is only 1. We can't continue because this condition is not true and this "process of request" is stopped.

⑥

Process	A ABCD	$\tilde{Q}$ ABCD	V ABCD
0	1031	0021	0102
1	3120	0102	
2	0231	3311	
3	2310	0411	
4	2011	6021	
5	0403	2103	

a) 1) There are no proceses with no recurses allocated.
2) $Q_i \leq V$

Process	V	M
——	{0, 1, 0, 2}	{}
P1	{0,1,0,2} + {3,1,2,0} = {3,2,2,2}	{P1}
P0	{3,2,2,2} + {1,0,3,1} = {4,2,5,3}	{P1, P0}
P5	{4,2,5,3} + {0,4,0,3} = {4,6,5,6}	{P1, P0, P5}
P2	{4,6,5,6} + {0,2,3,1} = {4,8,8,7}	{P1, P0, P5, P2}
P3	{4,8,8,7} + {2,3,1,0} = {6,11,9,7}	{P1, P0, P5, P2, P3}
P4	{6,11,9,7} + {2,0,1,1} = {8,11,10,8}	{P1, P0, P5, P2, P3, P4}

NO DEADLOCK

b) Safe sequence: {P_1, P_0, P_5, P_2, P_3, P_4}
(P_1, P_0, P_5: always; P_2, P_3: you can switch)

⑦ 5 processes that use 6 resources (A, B, C, D, E, F)

Resources					
A	B	C	D	E	F
3	6	7	4	5	8

	A						Q = R						
	A	B	C	D	E	F	A	B	C	D	E	F	
P_0	1	1	0	1	1	1	0	1	2	2	0	1	✓
P_1	1	0	0	2	1	2	0	0	3	0	0	1	✓
P_2	0	2	0	1	1	0	1	3	2	3	2	5	
P_3	0	0	5	0	0	0	1	0	0	0	2	1	✓
P_4	0	2	2	0	0	4	1	3	4	0	3	3	

V					
A	B	C	D	E	F
1	1	0	0	2	1

a) In order to know if there is a deadlock we use Banker's algorithm.

b) $Q_i < V$

Chosen	V	Finished
——	{1, 1, 0, 0, 2, 1}	{}
P3	{1,1,0,0,2,1} + {0,0,5,0,0,0} = {1,1,5,0,2,1}	{P3}
P1	{1,1,5,0,2,1} + {1,0,0,2,1,2} = {2,1,5,2,3,3}	{P3, P1}
P0	{2,1,5,2,3,3} + {1,1,0,1,1,1} = {3,2,5,3,4,4}	{P3, P1, P0}

Q_2 y Q_4 > V
so there is a DEADLOCK
No safe sequence can be found.

c) There is a deadlock produced by P_2 and P_4 because $Q_2 > V$ and $Q_4 > V$.

d) In order to avoid the deadlock we add one to resources B and F so we have (3, 3, 5, 3, 4, 5) and P_4 is the process that completes the safe sequences so now $Q_2 \leq V$, and when we perform $V + A_2$ = (3, 5, 5, 4, 5, 5) and $Q_4 \leq V$ and $V + A_4$ = (3, 7, 7, 4, 5, 9) which is the same as the total value of recources +1 in B and F