1. A memory consists of 4-page frames, currently holding pages 0 - 3. A 6-bit aging register is associated with each frame. The table shows which pages were referenced during each of 8 consecutive periods d.

Period d	0	1	2	3	4	5	6	7
Pages referenced	3	1 2	0	0 3	0	2	2	1

Determine which page will be replaced if a page fault occurs at the end of last d period.

Hint: See section aging registers   Page 3 will be replaced since there's only one instance.

2. Physical memory consists of 4-page frames, initially all empty. The following reference string is processed:

0 1 4 0 2 3 0 1 0 2 3 4 2 3

a) Show which pages are resident under the second chance page replacement algorithm. Indicate when page faults occur.

b) Assume that references to page 1 are write references (modifying page 1) and all others are read references. Show which pages are resident under the third chance page replacement algorithm. Indicate when page faults occur.
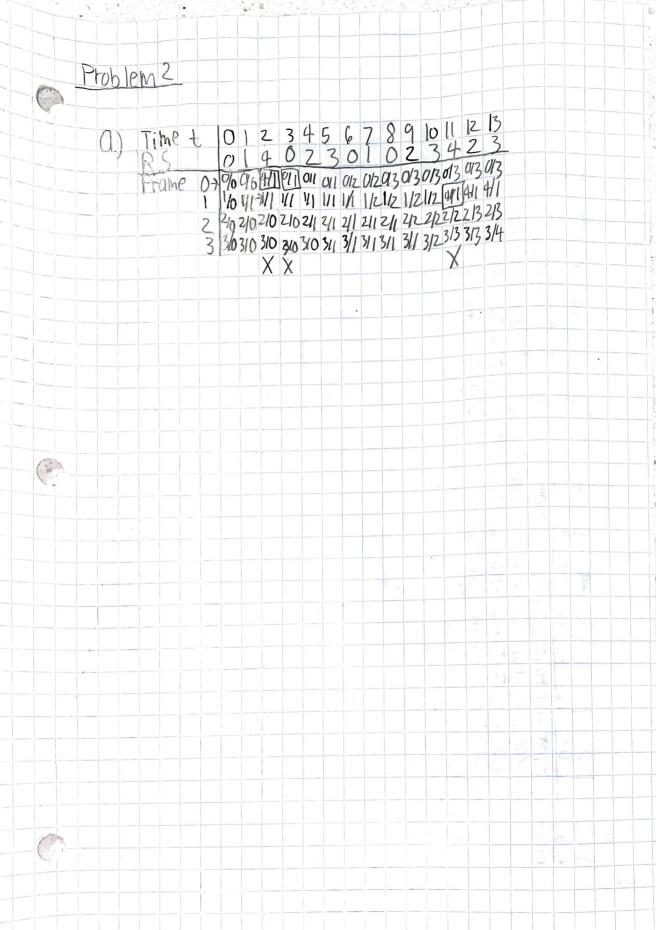
Hint: See sections and animation for second chance & third chance algorithms

3. A system uses demand paging to implement virtual memory.

- Access to physical memory is m = 100 ns. (Access to a page table is assumed to be negligible due to the use of caches and a TLB.)
- To process a page fault takes
   - S = 5 ms if a free page frame is available
   - S = 15 ms if no free frame is available and thus a resident page needs to be replaced
- On average, a free frame is available only 20% of the time.

Hint: See section page fault overhead

4. Write your experience on self-learning, do you prefer self-learning (using class time for reading and ask questions if stuck) or flipped class model (to read sections before class and use class for solving exercises) ?

I prefer in class lectures followed by working on worksheets.

Problem 2

a.)

Time t	0	1	2	3	4	5	6	7	8	9	10	11	12	13
RS		0	1	4	0	2	3	0	1	0	2	3	4	2	3

Frame															
0→	0/0	0/6	4/1	0/1	0/1	0/1	0/2	0/2	0/3	0/3	0/3	0/3	0/3	
1	1/0	1/1	1/1	1/1	1/1	1/1	1/1	1/2	1/2	1/2	1/2	4/1	4/1	4/1
2	2/0	2/0	2/0	2/0	2/1	2/1	2/1	2/1	2/1	2/2	2/2	2/2	2/3	2/3
3	3/0	3/0	3/0	3/0	3/0	3/1	3/1	3/1	3/1	3/1	3/2	3/3	3/3	3/4

X X   X

b

Time t	0	1	2	3	4	5	6	7	8	9	10	11	12	13
RS	0	w	4	0	2	3	0	w	0	2	3	4	2	3
Frame 0	0/00	0/00	4/10	0/10	0/10	0/10	0/20	0/20	0/30	0/30	0/30	4/10	4/10	4/10
1	1/00	1/01	1/01	1/01	1/01	1/01	1/01	1/02	1/02	1/02	1/02	1/02	1/02	1/02
2	2/00	2/00	2/00	2/00	2/10	2/10	2/10	2/10	2/10	2/20	2/20	2/20	2/30	2/30
3	3/00	3/00	3/00	3/00	3/00	3/10	3/10	3/10	3/10	3/10	3/20	3/20	3/20	3/30
Fault			X	X								X		