PAGE REPLACEMENT NUMERICALS *(Very Important)*

1) Consider Main Memory has 3 page frames (0,1,2).
Processor requires pages from Virtual Memory in the following sequence of page numbers:
2,3,2,1,5,2,4,5,3,2,5,2. Show and compare the implementation of FIFO, LRU and LFU.

FIFO	2	3	2	1	5	2	4	5	3	2	5	2	Hit Ratio = 0.25
Frame 0	2*	2*	2*	2*	5	5	5*	5*	3	3	3	3*	
Frame 1		3	3	3	3*	2	2	2	2*	2*	5	5	
Frame 2				1	1	1*	4	4	4	4	4*	2	
			HIT					**HIT**		**HIT**			

LRU	2	3	2	1	5	2	4	5	3	2	5	2	Hit Ratio = 0.42
Frame 0	2	2	2	2	2	2	2	2	3	3	3	3	
Frame 1		3	3	3	5	5	5	5	5	5	5	5	
Frame 2				1	1	1	4	4	4	2	2	2	
			HIT			**HIT**		**HIT**			**HIT**	**HIT**	

LFU	2	3	2	1	5	2	4	5	3	2	5	2	Hit Ratio = 0.50
Frame 0	2 (1)	2 (1)	2 (2)	2 (2)	2 (2)	2 (3)	2 (3)	2 (3)	2 (3)	2 (4)	2 (4)	2 (5)	
Frame 1		3 (1)	3 (1)	3 (1)	5 (1)	5 (1)	5 (1)	5 (2)	5 (2)	5 (2)	5 (3)	5 (3)	
Frame 2				1 (1)	1 (1)	1 (1)	4 (1)	4 (1)	3 (1)	3 (1)	3 (1)	3 (1)	
			HIT			**HIT**		**HIT**		**HIT**	**HIT**	**HIT**	

2) Consider Main Memory has 4 page frames (0,1,2,3)
Processor requires pages from Virtual Memory in the following sequence of page numbers:
7,5,3,2,1,0,4,1,6,7,4,2. Show and compare the implementation of FIFO, LRU and LFU.

FIFO	7	5	3	2	1	0	4	1	6	7	4	2	Hit Ratio = 0.16
Frame 0													
Frame 1													
Frame 2													
Frame 3													

LRU	7	5	3	2	1	0	4	1	6	7	4	2	Hit Ratio = 0.16
Frame 0													
Frame 1													
Frame 2													
Frame 3													

LFU	7	5	3	2	1	0	4	1	6	7	4	2	Hit Ratio = 0.16
Frame 0													
Frame 1													
Frame 2													
Frame 3													

OPTIMAL REPLACEMENT ALGORITHM

1. Another proposed replacement algorithm is called "**Optimal Replacement Algorithm**" (**OPT**)
2. We need to know beforehand, the order in which, pages will be used in the near future.
3. **The pages that will be used sooner, will be retained.**
4. **The pages that will not be used for the longest time will be replaced.**
5. Of course it is impossible to predict the pages to be used in the future.
6. But if we have had some **sample runs of the program in a simulator** then using that data as a reference, we can make safe predictions of the behavior of the program.

Consider Main Memory has 3 page frames (0,1,2).
Calculate Hits and Misses and suggest the best algorithm out of **FIFO, LRU and OPT**
Processor requires pages from Virtual Memory in the following sequence of page numbers:
4,7,3,0,1,7,3,8,5,4,5,3,4,7. (Sem 4 Comps IT Dec 2015 Exam question – 10 marks)

FIFO	4	7	3	0	1	7	3	8	5	4	5	3	4	7
Frame 0	4*	4*	4*	0	0	0*	3	3	3*	4	4	4	4	4*
Frame 1		7	7	7*	1	1	1*	8	8	8*	8*	3	3	3
Frame 2			3	3	3*	7	7	7*	5	5	5	5*	5*	7
	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	**HIT**	MISS	**HIT**	MISS

Total Attempts: 14. Hits = 2. Misses (Page Faults) = 12. **Hit Ratio = 2/14 = 0.117**

LRU	4	7	3	0	1	7	3	8	5	4	5	3	4	7
Frame 0	4	4	4	0	0	0	3	3	3	4	4	4	4	4
Frame 1		7	7	7	1	1	1	8	8	8	8	3	3	3
Frame 2			3	3	3	7	7	7	5	5	5	5	5	7
	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	MISS	**HIT**	MISS	**HIT**	MISS

Total Attempts: 14. Hits = 2. Misses (Page Faults) = 12. **Hit Ratio = 2/14 = 0.117**

OPT	4	7	3	0	1	7	3	8	5	4	5	3	4	7
Frame 0	4	4	4	0	1	1	1	8	5	5	5	5	5	7
Frame 1		7	7	7	7	7	7	7	7	4	4	4	4	4
Frame 2			3	3	3	3	3	3	3	3	3	3	3	3
	MISS	MISS	MISS	MISS	MISS	**HIT**	**HIT**	MISS	Miss	Miss	**HIT**	**HIT**	**HIT**	Miss

Total Attempts: 14. Hits = 5. Misses (Page Faults) = 9. **Hit Ratio = 5/14 = 0.357**