4. (a) A computer has 16 pages of virtual address space, but only 4 page frames. Initially, memory is empty. A program references the virtual pages in the following order: 0, 1, 2, 1, 2, 4, 3, 6, 0, 5, 7, 8, 7, 8, 2, 1, 3, 7, 3, and 4.

For each memory reference, write the virtual page stored in each page frame under the Least Recently Used (LRU) and First-In-First-Out (FIFO) page replacement policies (clearly show the page frames in memory for each reference).

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4. (a) A computer has 16 pages of virtual address space, but only 4 page frames. Initially, memory is empty. A program references the virtual pages in the following order: 0, 1, 2, 2, 1, 3, 4, 5, 0, 6, 7, 8, 8, 7, 1, 2, 7, 3, 4, 3.

For each memory reference, write the virtual page stored in each page frame under the **Most Recently Used (MRU)** and **First-In-First-Out (FIFO)** page replacement policies (clearly show the page frames in memory for each reference).

[10 Marks]

10

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- (b) Suppose you have 256MB of virtual memory, 32MB of physical memory, and the page size of 64KB (2<sup>16</sup>) bytes.
- (i). How many pages are there in virtual memory and in physical memory?

[SiMarks]

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No. of frams	L PM	= 32MB/	f .
		= 29 pge (	Trainey,

(ii). Assume that the relevant portion of your Page Table is as follows:

Page	Frame #	Valid Bit
. 0	2	1
1	3	0
4	8	0
8	0	1
11	6	1
15	7	1
17	4	1
21	13	1

Calculate the referenced address in main memory for the following virtual addresses: 0x0011D910 and 0x00157808.

10 Marks

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page No offset	
Pye NO 17 is in frame NO 4.	
- Physical Address  Ox 0004D910	
Ox10015 7808	
Page No 21 is in draw NO 13.	
. Physical Addres -	
Ox 000D7808	

. . .

(b) Suppose you have 4GB of virtual memory, 32MB of physical memory, and the page size of 16KB (2<sup>14</sup>) bytes.

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[5 Marks]

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(ii). Assume that the relevant portion of your Page Table is as follows:

Page	Frame #	Valid Bit
0	2	1
1	3	0
4	8	0
8	0	1
11 .	5	1
15	7	1
17	4	1
, 20	10	1

Calculate the referenced address in main memory for the following virtual addresses: 0x0002D910 and 0x00053808.

[10 Marks]

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