Cache Memory Simulation

Objective:
To see the effect frame size has on different replacement policies. Learn how to do simulation of cache performance. Use the simulator to compare the hit ratio for cache with different block sizes and replacement strategies. Write a report describing the results of FIFO and LRU replacement policy simulations for various numbers of possible addresses, and frame sizes.

Program Design Specification:
You are free to design your program in any way you wish with the following exceptions:

Program Input:
Specific prompt wording is up to you, but you need to allow the user to enter the following parameters:
1. The number of possible addresses.
2. The size of the frame.
3. What replacement policy to use.
4. Address input source (by random or user input, both should be available).
5a. If the addresses input source is user input then the user should be prompted to enter addresses until the user enters an invalid address. It should be made very clear to the user which addresses are valid.
5b. If the address input source is random then the user should be asked how many addresses should be generated. Random address input will randomly generate that number of addresses for the user.

Your simulator should take the above parameters in the *exact order* shown above. Do not vary the input format in any way.

*** Your program **must** prevent the user from causing any input exceptions. ***

Program Output:
Specific wording and format of program output is up to you, but should stick to the following order:
1. The string of addresses that either came from the user (Step 5a above) or from the random address generator (Step 5b above).
2. A formatted table showing the state of the cache frame as the addresses are called. This table should include a row labeled "hit" in which a marker (*) should be placed if there was a cache hit.
3. The hit ratio.

Output should be piped to both the standard interface/console output and to a file named "output.txt". File writing may be either appending or overwriting as long as the user can see all off the output from the last/current run of the program.

Hints:

LRU - This policy can be implemented easily with a stack of the same size of the frame. The head of the stack or queue should hold the most recently used address. If there is a hit on an item in the frame then that address should be moved to the head of the stack
FIFO – This policy can be most easily implemented with a queue of fixed length. If there is write to the cache frame then the new address would be added to the queue and any items on the queue exceeding the frame size should be removed.

For example if there are 23 address units:

1	2	5	3	2	6	3	1	5	3	2	5	3	1	4	1	5	4	5	4	5	4	3

If there are 3 frames in cache, and the replacement policy is FIFO, you use a stack and output *could* show:

i = 0:	1	2	5	3	3	6	6	1	5	3	2	2	1	4	4	5	5	5	5	5	5	5	3
i = 1:		1	2	5	5	3	3	6	1	5	3	3	2	1	1	4	4	4	4	4	4	4	5
i = 2:			1	2	2	5	5	3	6	1	5	5	3	2	2	1	1	1	1	1	1	1	4
Hits:					*		*					*	*			*		*	*	*	*	*	
	1	2	5	3	2	6	3	1	5	3	2	5	3	1	4	1	5	4	5	4	5	4	3

Total = 23
Hit = 10
Hit ratio = 10/23 =0.434

And there are 3 frames, and the replacement policy is LRU, you use a stack and output *could* show:

i = 0:	1	2	5	3	2	6	3	1	5	3	2	5	3	1	4	1	5	4	5	4	5	4	3
i = 1:		1	2	5	3	2	6	3	1	5	3	2	5	3	1	4	1	5	4	5	4	5	4
i = 2:			1	2	5	3	2	6	3	1	5	3	2	5	3	3	4	1	1	1	1	1	5
Hits:					*		*			*		*	*			*		*	*	*	*	*	

Total = 23
Hit = 11
Hit ratio = 11/23 = 0.47826086

A report describing the results of FIFO and LRU replacement policy simulations for various numbers of possible addresses, and frame sizes. Your report should explain (in enough details for me to understand) what you've done, how you implemented and how you tested your work.

The general report format is:
1. Introduction
2. The background knowledge
3. Key source code
4. Results
5. My work and encountered difficulties

- The report should be over 14 pages in 1.5 space and 11 font size.
- **DO NOT just copy others or use others, otherwise both of you will be failure**
- **Show the program on 24th Dec. afternoon (2:30) in B3-234**
- **Submit the hardcopy report on 24th Dec. afternoon (2:30) in B3-234**