Operating System HW4

1. A computer has four page frames. The time of loading, time of last access, and the R and M bits for each page are as shown below (the times are in clock ticks):

Page	Loaded	Last Reference	R	M
0	126	279	0	0
1	230	260	1	0
2	120	272	1	1
3	160	280	1	1

Solution:

(a) Which page will NRU replace?
Page 0, 因為其 R, M 的值皆為 0，NRU replace 的優先度如下，Priority 數值越低，代表越優先被替換。

Priority	R	M
0	0	0
1	0	1
2	1	0
3	1	1

(b) Which page will FIFO replace?
Page 2, 因為其最早被 load。

(c) Which page will LRU replace?
Page 1, 因為其最近一次的 reference 時間最早。

(d) Which page will second chance replace?
Page 0, 因為其 R bit 為 0。

2. A small computer has 8 page frames, each containing a page. The page frames contain virtual pages A, C, G, H, B, L, N, and D in that order. Their respective load times were 18, 23, 5, 7, 32, 19, 3, and 8. Their reference bits are 1, 0, 1, 1, 0, 1, 1, and 0 and their modified bits are 1, 1, 1, 0, 0, 0, 1, and 1, respectively. Which page will the second chance page replacement algorithm replace?

Solution:
先將這些page依照 load 時間先後排序，得到 N, G, H, D, A, L, C, B，最前面 reference bit 為 0 的 page 是 D ，因此 page D 會被 replace。

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3. What is the difference between a physical address and a virtual address?

Solution:
(1) virtual address 由 CPU 產生，而 physical address 是 virtual address 經 MMU 所轉換而來
(2) process 使用的是 virtual address，process 本身並不知道實際上的資料存於記憶體在甚麼地方，存取的時候需另外由 MMU 轉換成 physical address 再進行存取
(3) virtual address 的數量與機器的架構有關，physical address 的數量則是被 unit 大小及實際記憶體大小所限制

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4. Are there any circumstances in which clock and second chance choose different pages to replace? If so, what are they?

Solution:
兩種演算法在相同環境下，替換 page 的選擇是一樣的 (FIFO)，只有實作的方式不同而已，clock 演算法不需要一直 push page 到 list 的最後面

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5. A small computer has four page frames. At the first clock tick, the R bits are 0111 (page 0 is 0, the rest are 1). At subsequent clock ticks, the values are 1011, 1010, 1101, 0010, 1010, 1100, and 0001. If the aging algorithm is used with an 8-bit counter, give the values of the four counters after the last ticks.

Solution:

每當 tick 增加時，把每個 counter 右移 (shift right) 一個 bit ，並把現在的 R bit 放入最左邊的 bit

Result:

Page	Counter
0	01101110
1	01001001
2	00110111
3	10001011