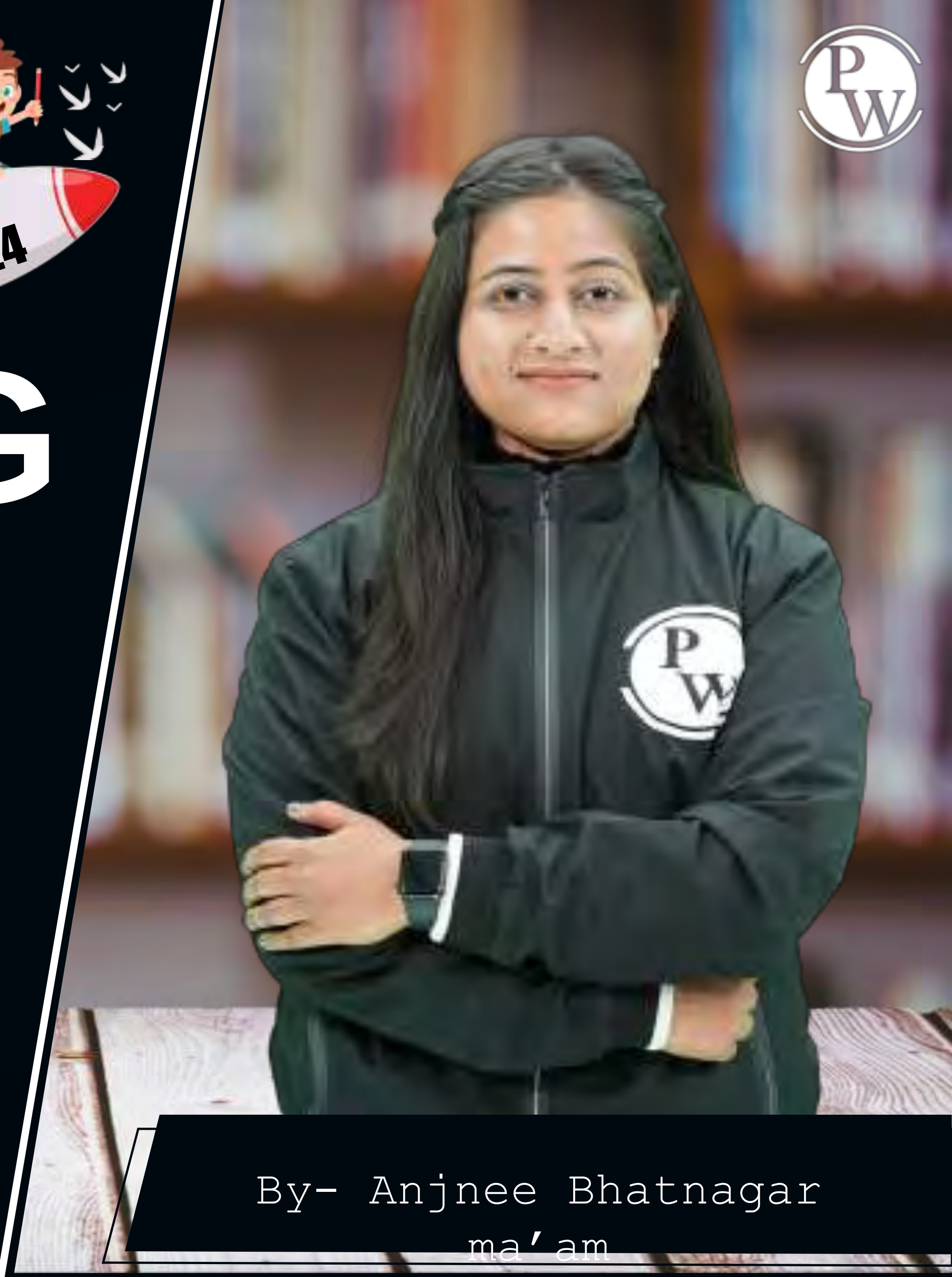
# CS & IT ENGINEERING


## Operating System

### Memory Management

**DPP_02 Discussion Notes**



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## [MCQ]

#Q. When a program tries to access a page that is mapped in address space but not available in physical memory, then __________ occurs ?

A. segmentation fault

B. fatal error

C. page fault

D. no error

[MCQ]

#Q. Effective memory access time for virtual memory, is directly proportional to ___________ ?

A. Page-fault rate ↑

B. Hit ratio of page access in main memory ↑

EMAT ↓

C. Main memory access time

D. Hit ratio of TLB

**[MCQ]**

#Q. It is advantageous for the page size to be large because ?

A. Less unreferenced data will be loaded into memory

B. Virtual address will be smaller

C. Page table will be smaller

D. Large program can be run

P.T.S ⇒ # of pages * P.S

**[NAT]**

#Q. A demand paged memory environment has physical memory access time of 50 microseconds without page fault and with page fault it is 10 milliseconds. If the page fault rate is 5% then the effective memory access time is _____ microseconds (rounded up to 1 decimal place) ?

$$EMAT = PFR\,(10\ msec) + (1 - PFR)\,(50\ \mu sec)$$

$$= 0.05\,(10\ msec) + 0.95\,(50\ \mu sec)$$

$$= 547.5\ \mu sec$$

[NAT]

#Q. A demand paged memory environment has physical memory access time of 50 microseconds and page fault service time of 5000 microseconds if the replaced page is not dirty. The page fault service time of 10 milliseconds if a dirty page is replaced. Assume that among all pages which are getting replaced, only 2% are dirty, and 95% page hit ratio then the effective memory access time is _____ microseconds ?

EMAT = Page hit (2 * M.M) + Page miss (Not dirty * PFST + Page dirty * PFST)

$= 0.95(2 * 50) + 0.05[0.98(5000) + 0.02(10000)]$

$= 350\ \mu sec.$

## [MCQ]

#Q. A main memory can hold 3-page frames and initially all of them are vacant. Consider the following stream of page requests:

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

If the stream uses FIFO replacement policy, the hit ratio h will be ?

FIFO policy.

| | |
|---|---|
| ~~2~~ | ~~6~~ 1 |
| ~~3~~ | ~~2~~ 4 |
| ~~4~~ | ~~5~~ 6 |

$\frac{2}{11}$

A. 11/3

B. 1/11

C. 3/11

D. 2/11

[NAT]

#Q. In a demand paging system, a page table is held in registers. For a memory access, it takes 2000 milliseconds if there is a page fault; but it takes 10 milliseconds when there is no any page fault. For a page fault rate of 0.01, the effective memory access time (rounded up to1 decimal places) is _________ milliseconds ?

$$EMAT \Rightarrow 0.99\,(10\,m) + 0.01\,(2000\,m)$$

$$\Rightarrow 9.9m + 20.00$$

$$\Rightarrow 29.9 \text{ msec}$$

**[NAT]**

#Q. In a paged memory management technique, the total available memory for user processes is 64 KB. The system uses 8KB pages. There are 2 processes P1, P2 to be stored in memory. And the sizes of P1 and P2 are 36 KB and 22 KB respectively. The total amount of internal fragmentation against total allocated space is ____ % (Rounded up to 1 decimal place) ?

P.S = 8KB Total available memory = 64KB

$P_1$ : $8KB * 5 = 40KB - 36KB = 4KB$.

$P_2$ : $8KB * 3 = 24KB - 22KB = 2KB$.

$\Rightarrow \frac{4+2}{64} = \frac{6}{64} \Rightarrow 0.09375 * 100 \Rightarrow 9.375 \simeq 9.4\%$

## [NAT]

#Q. Suppose that we decide to design a virtual memory system with virtual address space of 256GB and each page table entry is of 4 bytes. Assume that each page table is fit into a single physical frame. Further, assume that we are going to design the multi-level paging scheme with no more than two levels of tables. The minimum page size that your system must have ____ Kbytes ?

$$\text{I}: \quad \frac{2^{38}}{2^{x}} = 2^{38-x} * 4B \Rightarrow 2^{40-x}.$$

$$P.S = 2^{14} = \underline{16kB}.$$

$$\text{II}: \quad \frac{2^{40-x}}{2^{x}} = 2^{40-2x} * 4B \Rightarrow 2^{42-2x}.$$

$$2^{x} = 2^{42-2x} \Rightarrow 42 = 3x$$

$$\boxed{x = 14}$$

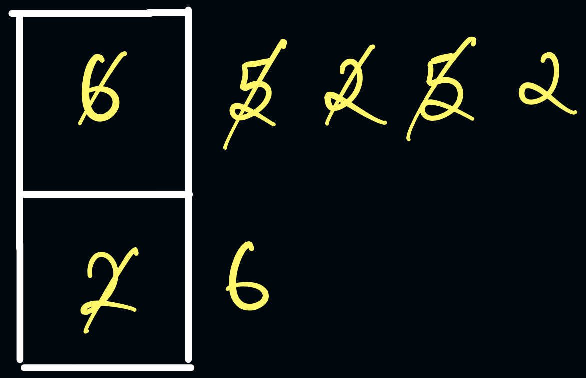
**[NAT]**

#Q. A virtual memory system has only 2-page frames which are empty initially. Using demand paging the following sequence of page reference is passed through this system.

6, 2, 5, 2, 5, 6, 5, 6, 2, 6, 5, 6, 5, 2, 6

The minimum possible number of page faults to satisfy all above requests is 7 ?

optimal page replacement policy.



$$\frac{7}{15}$$

**[NAT]**

#Q. Consider a demand paging environment with 32-bits virtual address and 3-level page tables. The page size used is 2KB and each page table entry is of 4 bytes which includes translation and some extra bits for protection etc. The maximum size of page table required across all the levels is ____Kbytes ?

$P.S = 2KB = 2^{11}$ Bytes

← 32 bit →

| $P_1$ | $P_2$ | $P_3$ | d |
|---|---|---|---|
| 3 | 9 | 9 | 11 |

# of page table enteries possible in one page $\Rightarrow \frac{2^{11}}{2^2} = 2^9$

I ⇒ 1

II ⇒ $1 * 2^3 = 8$

III ⇒ $8 * 2^9 = 4096$

Total page tables = 1+8+4096 = 4105.

4105 * 2kB = 8210kB.

**[NAT]**

#Q. Consider a paged memory system with page table size of 8Kbytes. The page size is 16Kbytes. Each page table entry contains frame number and 2 protection bits. The physical address size is 44-bits. The size of logical address is ___25___ bits ?

$$P.T.S = \text{Pages} * P.T.E$$

$$d = 2^{14}\,B = 14 \text{ bits}$$

$\longleftarrow 44 \longrightarrow$

| F | d |
|---|---|
| 30 | 14 |

$\longleftarrow 25 \longrightarrow$

| P | d |
|---|---|
| 11 | 14 |

$$P.T.E = 30 + 2 = 32 \text{ bits } (4 \text{ Bytes})$$

$$\text{No. of pages} \Rightarrow \frac{2^{13}\,B}{2^{2}\,B} \Rightarrow 2^{11}$$

# [NAT]

#Q. Consider the following page references:

0, 3, 0, 5, 6, 3, 0, 5, 0, 7, 5, 7, 9, 7

The system is using optimal policy for page replacement and has 4 frames (initially empty). Memory access time is 7 milliseconds when there is not page fault and is 70 milliseconds when there is a page fault. The effective memory access time is __34__ milliseconds?

| | |
|---|---|
| ~~0~~ | 7 |
| ~~3~~ | 9 |
| 5 | |
| 6 | |

$$\text{Hit ratio} = \frac{8}{14}, \quad \text{Miss ratio} = \frac{6}{14}$$

$$EMAT = \frac{\cancel{8}^{\,4}}{\cancel{14}_{\,\cancel{2}}}(7\,ms) + \frac{\cancel{6}^{\,3}}{\cancel{14}_{\,\cancel{2}}}(\cancel{70}^{\,10}\,ms)$$

$$EMAT = 4\,ms + 30\,ms$$

$$\Rightarrow \underline{34\,ms}.$$

# THANK - YOU