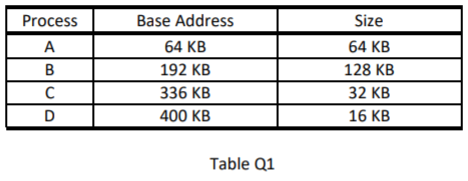
CPE 334: Problem session #3

1. A computer system has a total memory of 512 KB. It supports multiprogramming with contiguous memory allocation using flexible-size partitions. The operating system uses 64 KB memory, starting at address 0. At a given moment in time, the memory is occupied by four processes, A, B, C and D, as shown in Table Q1.  
     
     
     
     
     
     
     
     
     
     
     
     
     
     
     
     
     
     
     
   a) List the areas of free memory (holes) giving their start address and size.  
     
   Hole1: 192 - (64 + 64) = 64KB  
   Hole2: 336 – (192 + 128) = 16KB  
   Hole3: 400 – (336 + 32) = 32KB  
   Hole4: 512 – (400 + 16) = 96KB  
     
   b) Suppose the operating system receives a request from a new process for 30 KB memory to be allocated. Assuming the free memory is searched in order of start address, what would be the base address of this new process using each of the following strategies: (i) First-Fit, (ii) Best-Fit, and (iii) Worst-Fit. In each case, give a brief explanation of your answer.  
     
   (i) First-fit = Hole 1, base address 128 KB because it is the first that has the sufficient size.

(ii) Best-Fit = Hole 3, base address 368 KB because it leaves the smallest size of space which is only 2 KB.

(ii) Worst-Fit = Hole 4, base address 416 KB because it leaves the biggest size of space which is 66 KB.

1. a) Consider a paging system using a linear page table stored in kernel memory.  
      
   (i) If a memory reference takes 200 nanoseconds, how long does a paged memory reference take?

400 nanoseconds

(ii) If we add a Translation Lookaside Buffer (TLB), and 75% of all page table references are found in the TLB, what is the effective memory reference time? Assume that finding an entry in the TLB takes zero time.

(75% \* 200) + (25% \* 400) = 250ns  
  
b) Consider a paging system with a virtual address space of 64 pages of 1024 Bytes each, which is mapped onto a physical memory of 32 page frames.   
  
(i) How many bits are there in the virtual address?

(Virtual) 64 = 2^6

(Size) 1024 = 2^10

6 + 10 = 16 bits  
  
(ii) How many bits are there in the physical address?

(Physical) 32 = 2^5

(Size) 1024 = 2^10

10+5 = 15 bits

1. A paged memory system uses a page size of 1024 Bytes. The size of a page table entry is 4 Bytes and the virtual address space is 2^30 Bytes.   
   a) What is the size of the page table if a linear (single level) page table is used?

1024 = 2^10

(virtual address / page size) = amount of pages

Total pages : (2^30/2^10) = 2^20 pages   
Size of page table = 2^20 \* 2^2 = 2^22 byte

b) What is the size of the outermost (1st level) page table if a two-level paging scheme is used? Assume that a 2nd level page table completely occupies one page frame.

Pages in 2nd level = page size / page table entry size = 2^10/2^2 = 2^8

Pages in 1st level = total pages / 2nd level page = 2^20/2^8 = 2^12

Size of outermost (1st level) = 2^12 \* 2^2 = 2^14 byte  
  
c) What is the size of the outermost (1st level) page table if a three-level paging scheme is used? Assume that a 2nd or 3rd level page table completely occupies one page frame.

d) What is the minimum number of levels of page tables needed in this system to ensure that the outermost page table will fit within a single page frame?