# Assignment 3

**Problem 1.**

What is the total capacity of RAID 0 with 10 drives?

RAID 0 - non-redundant (full capacity of drives) = drive capacity * 10 = 1 TB * 10 = 10 TB

What is the total capacity of RAID 5 with 10 drives?

RAID 5 - parity redundancy - uses 1 drive for parity so have 9 data drives = drive capacity * 9 = 1 TB * 9 = 9 TB

How many blocks are needed for spanned and unspanned records, respectively?

*Unspanned*

$$\left\lfloor \frac{block\ size}{record\ size} \right\rfloor = \left\lfloor \frac{4096}{2050} \right\rfloor = = \textbf{1 record/block (unspanned)}$$

*Spanned*

$$\frac{block\ size}{record\ size} = \frac{4096}{2050} = \textbf{1.99 record/block (spanned)}$$

What is the block (space) utilization in both cases?

*Unspanned*

utilization = used space/total space $= \frac{1\ record\ per\ block * 2050\ bytes\ per\ record}{4096\ bytes\ per\ block} = 0.5$

*Spanned*

utilization = used space/total space $= \frac{1.99\ records\ per\ block * 2050\ bytes\ per\ record}{4096\ bytes\ per\ block} = 0.995$

Assume that the disk has a read bandwidth of 1 GB/sec. Suppose that data is stored sequentially. What is the time to read all records in the unspanned configuration?

*Unspanned*

# of blocks in unspanned $= \frac{\#\ records}{\#\ records\ per\ block} = \frac{100{,}000}{1\ record} = 100{,}000$ blocks.

Transfer time $= \frac{\#\ blocks * size\ of\ a\ block}{tranfer\ \text{bandwidth}} = \frac{100.000 * 4096}{1\ GB/sec} = 38\ sec$

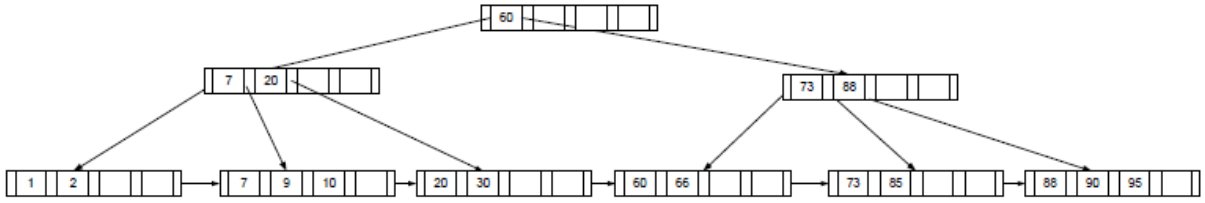
**Problem 2**

1. Bytes/track = (bytes/ sector) x (sectors/track) = 1024 x 100 = 102400 bytes = 100KB.
2. Bytes/surface = (bytes/track) x (tracks/surface) = 100KB x 4000 = 400,000KB.
3. Bytes/disk = (bytes/surface) x (surfaces/disk) = 400,000 x 10 x 2 = 80,000,000KB.
4. 4000, i.e., same as the number of tracks.
5. One complete rotation takes 1/7200 in a minute = 1/7200 x 60 seconds ≈ 0.0083 seconds = 8.3 ms. The average rotational delay is half of the rotation time, i.e., 4.15 ms.
6. A track has 100KB. It takes about 8.3ms to make a revolution. Hence, transfer rate is 100KB/8.3ms ≈ 12.05 KB/ms.

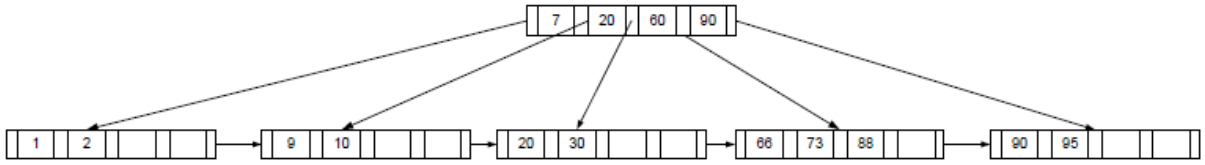
   If you are asked to give the TOTAL transfer time then this is given by:
   Total transfer time = seek time + latency + transfer time = 10ms + 4.15ms + 12.05ms = 26.2ms

**Problem 3**

Insert Tree:



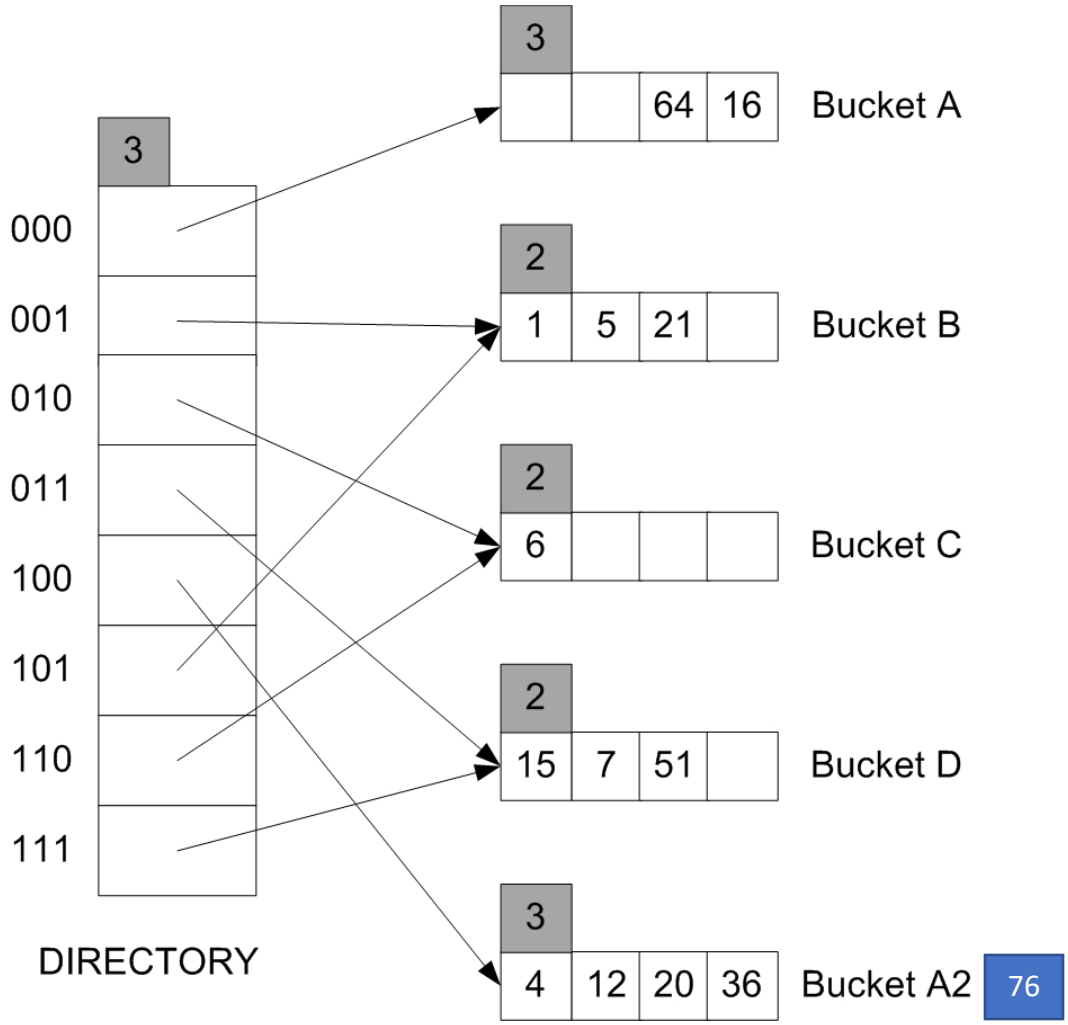

Delete Tree:



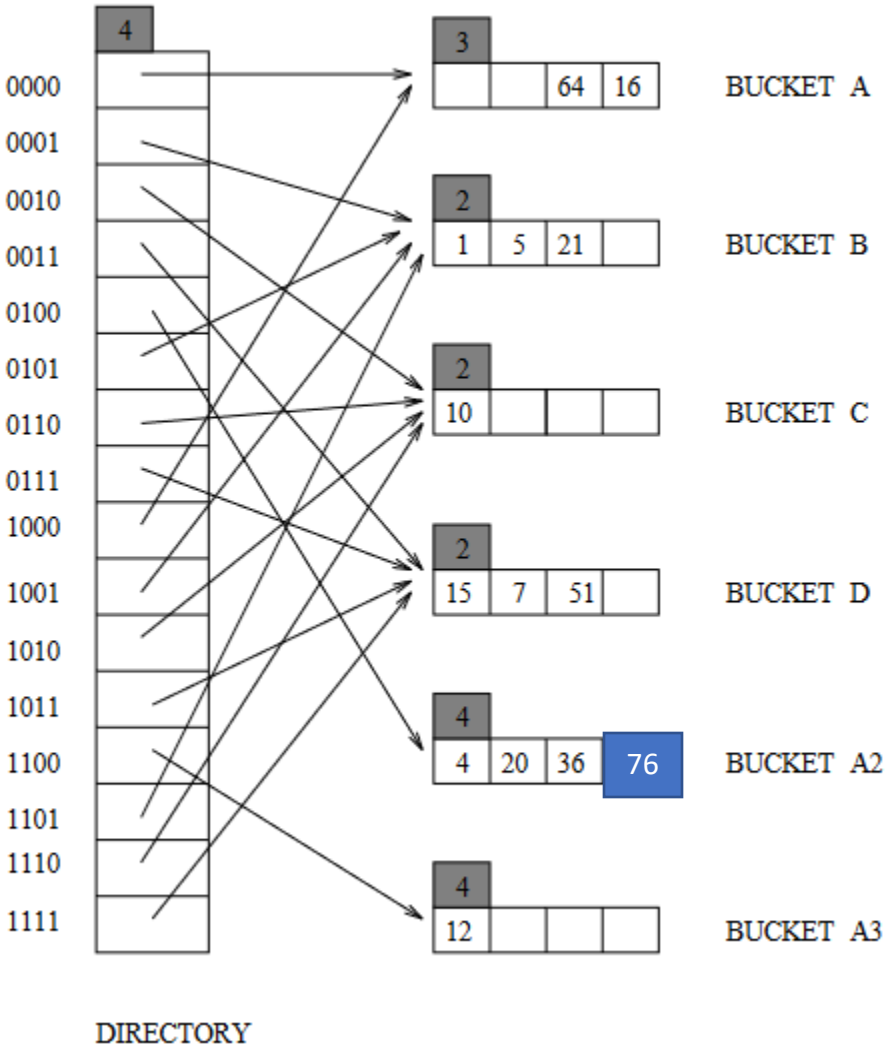

**Problem 4**

1. M = 1

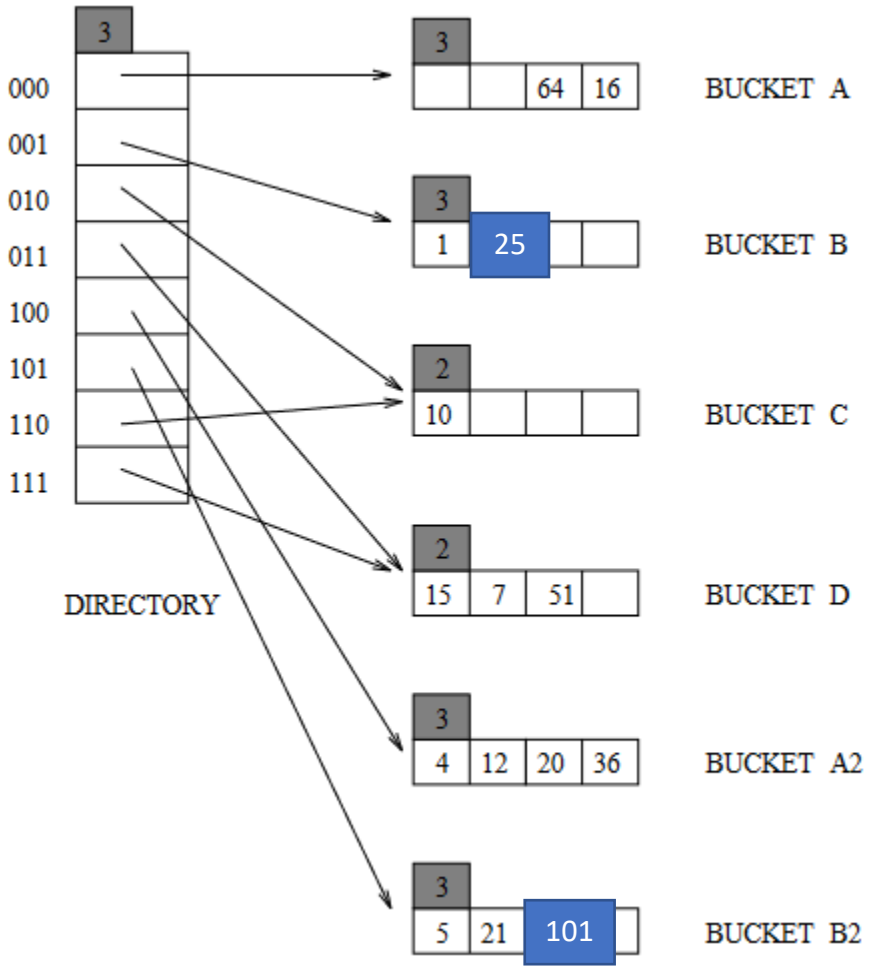
2.




76 will be inserted in bucket A2. We need to split the bucket. Since local is 4 and global is 3 we need to double the size of the directory. The new index is below.




3. 25 and 101 will both go into bucket B, 25 ends in 001 and 101 ends in 101. We need to split the bucket after we insert 101. The directory does not double in size because local and global are equal to 3.


3
000
001
010
011
100
101
110
111
DIRECTORY
3
64
16
BUCKET A
3
1
25
BUCKET B
2
10
BUCKET C
2
15
7
51
BUCKET D
3
4
12
20
36
BUCKET A2
3
5
21
101
BUCKET B2