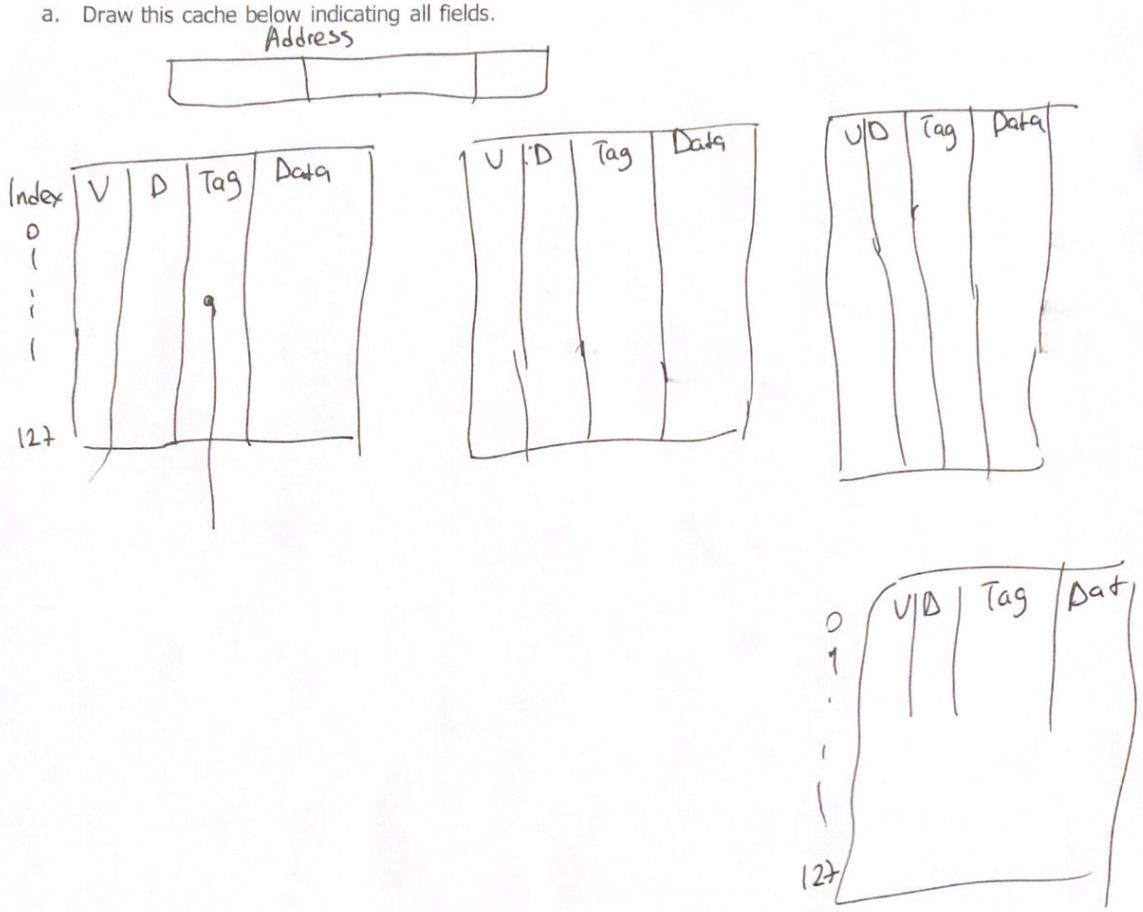
Cache And AMAT

We have **a 4-way set associative cache** with **data block size of 128 bytes**. The **physical address** width is **34 bits**. For each block there is a **valid** bit and a **dirty** bit. The width of the **index field** is **7 bits**.

a. Draw this cache below indicating all fields.



b. Write down the bit widths of all fields at the above cache

offset size = $\log_2$ (Block Size)

Block size = 2^7 bytes

offset size = 7 bits

Block address = 34 − 7 = 27

27 = tag + 7 (index)

Tag = 20 bits

c. What is the data size of the cache in KB?

$2^7 \times 4 \times 2^7 \text{ bytes} = 2^{16} \text{ bytes} = 2^{10} \times 2^6 \text{ bytes} = 64\text{ KB}$

index size; # of assoc.; block size

d. What is the total size of the cache in KB?

$(20 + 1 + 1 + 8 \times 128) \times 4 \times 2^7 = (22 + 1024) \times 2^9 \text{ bits}$

$= 535552 \text{ bits} / 8$

$= 66944 \text{ bytes} / 1024$

$= 65.375\text{ KB}$

tag; Dirty; valid; 1byte = 8bits; block size; # of assoc.

e. Compute **average memory access time** considering all costs **including the time required for address translation** by the help of the below table. Show your computations clearly.

Operation	Time required
L1 cache hit time	3ns
L1 cache hit rate	90%
L2 cache hit time	25ns
L2 cache hit rate	80%
Main memory hit time	500ns
Page fault rate	0.2%
Disk access time	30,000ns
TLB hit time	2ns
TLB hit rate	95%
Page table access time	300ns

AMAT

$AMAT = 3 + 0.1 \times (25 + 0.2 \times (500 + 0.02 \times 30000)) + 2 + 0.05 \times 300$

address translation

$= 44.5\text{ns}$