Before Starting Homework

- Do not upload to generative AI.
- Complete the Programming Assignment before beginning the written portion of the homework.
- Answer all questions below.
- **Type** answers and upload to Canvas in PDF format.

QUESTION 1 : ACCESSING VALUES FROM MEMORY

Assume you have a 2-way associative TLB that holds a total of 8 page entries, and that the TLB initially holds the following:

Set	Tag	PFN	Valid									
0	3	-	0	9	13	1	0	-	0	077	2	1
1	3	45	1	2	-	0	4	-	0	10	-	0

Also assume the relevant entries of your page table are listed as follows:

VPN	PFN	Valid
0	0	1
010	-	0
15	2142	1
18	213	1

Finally, assume you have a single level of cache that holds 16 lines with 4-byte block size, and that cache initially holds the following:

IDX	Tag	Valid	B0	B1	B2	B3	IDX	Tag	Valid	B0	B1	B2	B3
0	19	1	99	11	23	11	8	13	1	17	19	27	22
1	7172	1	77	23	215°	2	9	12	1	32	47	81	10
2	2152	1	13	7	23	5	10	272	1	1	0	7	12
3	-	0	-	-	-	-	2112	3	1	2	7	12	31
4	19	1	99	2112	23	11	12	-	0	-	-	-	-
5	2150	1	10	7	3	25	13	8	1	92	21	65	1
6	-	0	-	-	-	-	2142	2142	212	0	17	1	5
7	3	1	7	52	45	3	15	-	0	-	-	-	-

Assume that your page size is 64 bytes and that there is only a single page table (i.e. no hierarchical page tables). Assume the following virtual address are accessed from the TLB, page table, and cache above:

- 1. 1017
- 2.1186
- 3. 34455

For each address, answer the following questions:

- a What are the TLB tag and TLB index?
- b Is the VPN in the TLB?
- c If not in the TLB, is the VPN in the page table?
- d What is the corresponding PFN, if known?
- e What are the cache tag, index, and offset?
- f Is the corresponding data in cache, and if so what is the value?