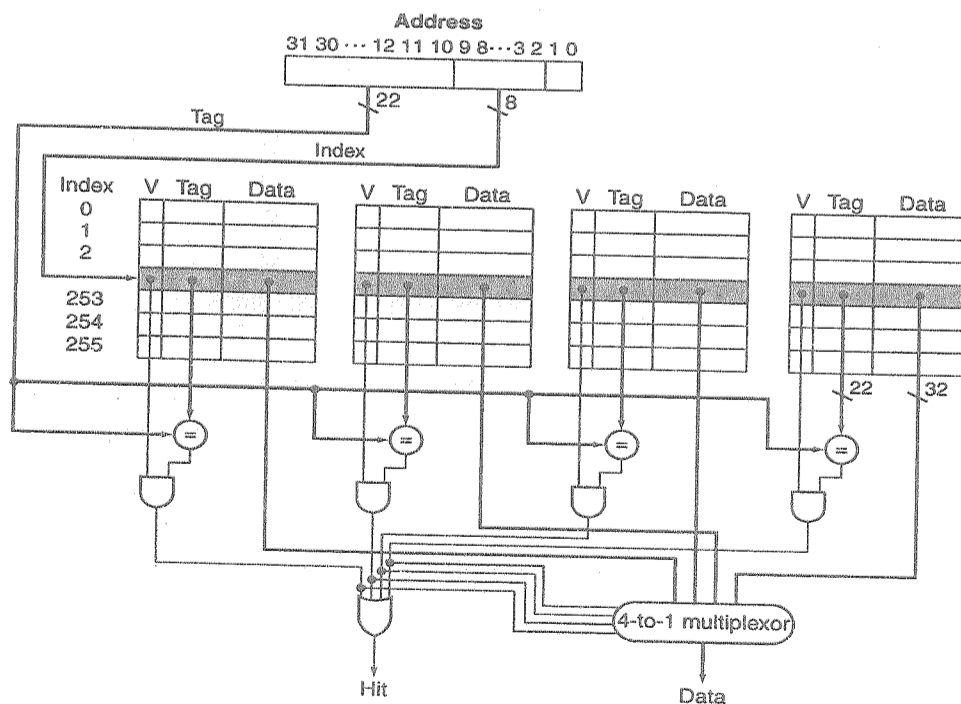


問答題 (共 100 分)：

1. (16 分) Datapath and control unit are two main parts of a central processing unit (CPU). They are responsible for different jobs to execute instructions. To achieve high performance, they must cooperate very closely and well.
 - (a) For datapath, multi-cycle datapath and pipelined datapath are two different approaches to execute instruction. Give principles to convert a multi-cycle datapath into a pipelined datapath.
 - (b) For control part, give differences between multi-cycle datapath and pipelined datapath in terms of design, support, and propagation ways.

2. (15 分) Hit time, miss rate and miss penalty are three metrics for cache optimizations. Therefore, the cache optimization can be classified into five categories: I. Reducing the hit time, II. Increasing cache bandwidth, III. Reducing the miss penalty, IV. Reducing the miss rate, and V. Reducing the miss penalty or miss rate via parallelism. Please classify the following cache optimizations according to the categories (I. to V.):
 - (a) Trace caches (b) Larger block size (c) Critical word first (d) Avoiding address translation (e) Small and Simple caches (f) Compiler prefetching (g) Multibanked caches (h) Non-blocking caches (i) Multilevel caches (j) Hardware prefetching (k) Way prediction

3. (10 分) The following block diagram is a 4KB, 4-way set associative cache with 1-word blocks for a 32-bit byte addressing memory system. Draw the block diagram of an 8KB, 2-way set associative cache with 32-word blocks for a 40-bit byte addressing memory system.



4. (9 分) Design a 64-bit carry-lookahead adder (CLA) using 2-level group carry generation with P/G (i.e. 1st-level with [3:0], [7:4], ... & 2nd-level with [15:0]). What is the gate delay of this CLA?

5. (15 分) Suppose the cylinder head is currently (time = 0) located at cylinder 201 and the direction of movement is towards cylinder 200. There are 8 access requests with the deadline and cylinder as tabulated below. What are the access sequences produced by the SCAN, Circular-SCAN, and EDF-SCAN algorithms? For Circular-SCAN, suppose that the direction of modification is upward (from cylinder 0 upward). For EDF-SCAN, suppose a batch is 100 ms.

| request | deadline (ms) | cylinder |
|---------|---------------|----------|
| A | 91 | 82 |
| B | 248 | 7 |
| C | 125 | 70 |
| D | 35 | 100 |
| E | 101 | 150 |
| F | 205 | 188 |
| G | 292 | 96 |
| H | 199 | 173 |
| I | 52 | 258 |
| J | 276 | 300 |

6. (10 分) Consider two processes P1 and P2, where the periods are $p_1 = 50$ and $p_2 = 75$ and the processing times are $t_1 = 25$ and $t_2 = 30$, respectively. Schedule the two processes using the following algorithms and illustrate their executions using Gantt charts.
- Rate-monotonic scheduling
 - Earliest deadline first
7. (15 分) This function is proposed for use in an operating system, with the definitions of Process, Process_Set and other functions given elsewhere.

```
Process next_process(Process_Set available_processes) {
    Process_Set A =
        highest_valuation(available_processes); /* priority ranking */
    Process_Set B = earliest(A); /* actual arrival time */
    Process c = random_selection(B); /* tie-breaker */
    return c; /* run this process next */}
```

- Explain why this function could lead to processor starvation among the available processes.
 - Suppose one of the criteria used by the highest_valuation function is the process's fraction of virtual memory pages currently in main memory. Explain why this is not a good idea.
8. (10 分) Please answer the following questions.
- Define the working set of a process.
 - What would be the effect of a large number of page faults by a process on that process's page allocation on a non-preemptive operating system?