

## EXPERIMENT – 12

### IMPLEMENTATION OF CACHE MEMORY

**Aim:** To implement cache memory and verify its importance and operation using Logisim.

**Tools Required:** Logisim

**Components/devices can be used:** Memory, registers, Tri-state Buffers, Comparators, Selection Units, CPU.

**Need and purpose:**

A CPU cache is a hardware cache used by the central processing unit (CPU) of a computer to reduce the average cost (time or energy) to access data from the main memory. A cache is a smaller, faster memory, closer to a processor core, which stores copies of the data from frequently used main memory locations. Most CPUs have different independent caches, including instruction and data caches,

The basic operation of the cache is as follows. When the CPU needs to access memory, the cache is examined. If the word is found in the cache, it is read from the fast memory. If the word addressed by the CPU is not found in the cache, the main memory is accessed to read the word. A block of words containing the one just accessed is then transferred from main memory to cache memory. The block size may vary from one word (the one just accessed) to about 16 words adjacent to the one just accessed. In this manner, some data are transferred to cache so that future references to memory find the required words in the fast cache memory.

**Model Diagram / Table:****Pre-Lab:****1. What is the purpose of cache memory in computer systems?**

Answer: Cache memory is used to store frequently accessed data and instructions closer to the CPU, reducing the average time to access data from the main memory. It helps in improving the overall performance of the system by reducing latency and increasing data throughput.

**2. Describe the basic structure of a cache memory.**

Answer: Cache memory typically consists of multiple cache lines or sets, each containing multiple cache blocks. Each block stores a subset of data from the main memory along with its corresponding tag and metadata. The cache is organized into levels (L1, L2, etc.) based on proximity to the CPU, with lower levels having smaller and faster caches.

**3. Explain the concept of cache hit and cache miss.**

Answer: A cache hit occurs when the CPU requests data that is already present in the cache memory. In contrast, a cache miss occurs when the requested data is not found in the cache, necessitating a fetch from the main memory. Cache hits result in faster access times, while cache misses incur additional latency due to the need to retrieve data from slower main memory.

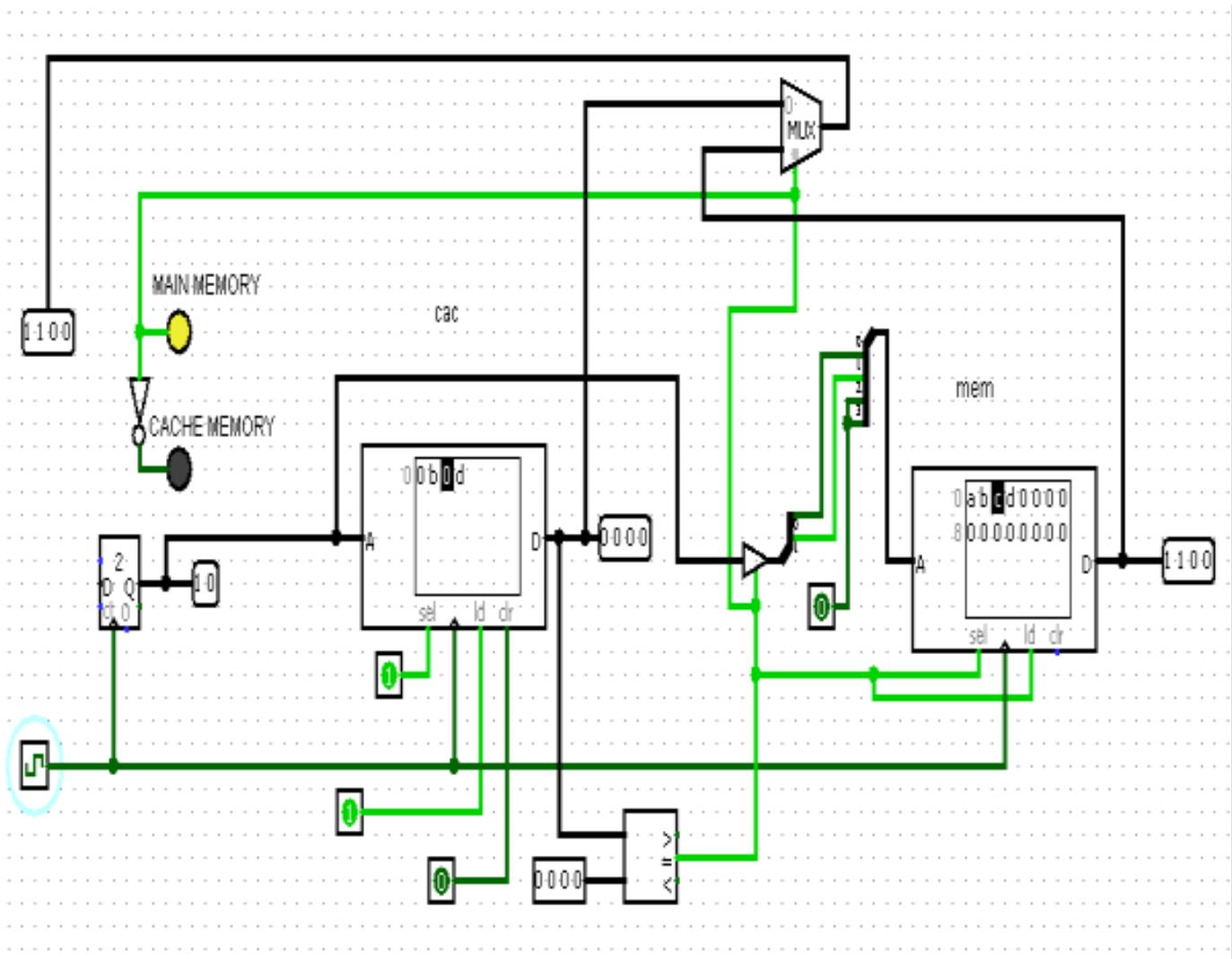
**4. What factors influence the effectiveness of a cache memory design?**

Answer: Several factors affect cache memory performance, including cache size, associativity, block size, and replacement policy. A larger cache size generally leads to a higher hit rate but increases hardware complexity and cost. Associativity determines how cache blocks are mapped to cache sets, affecting cache conflict and hit rate. Block size influences spatial locality and cache utilization. The replacement policy dictates which cache block to evict upon a cache miss, impacting cache performance under different access patterns.

## 5. How does cache memory contribute to overall system performance?

Answer: Cache memory plays a crucial role in reducing the average memory access time and improving the overall performance of computer systems. By storing frequently accessed data closer to the CPU, cache memory reduces the number of accesses to the slower main memory, thereby decreasing latency and increasing the throughput of memory operations. Efficient cache management strategies ensure that the most relevant data is retained in the cache, maximizing the benefits of caching.

### Circuit Diagram:



**Procedure:**

1. Analyze the importance and working of the cache memory with given model diagram.
2. Analyze the condition where the data is to be fetched from cache memory if it is available in cache else in the main memory.
3. Select the modules in Logisim required to implement the above functionality.
4. Verify the process of data fetching from the cache and main memory in the implemented logic circuit.

**Viva Questions and answers:**

1. Can you explain the concept of cache memory and its significance in computer systems?
2. How does cache memory contribute to improving the performance of a computer system?
3. What are the main components of a cache memory system, and what roles do they play in its operation?
4. Describe the difference between a cache hit and a cache miss.
5. What factors influence the effectiveness of a cache memory design, and how do they impact cache performance?

**Result:** The experiment successfully demonstrated the cache memory and its operation using Logisim.