

# Computer Architecture Exam Questions And Solutions

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**Decoding Computer Architecture Exam Questions and Solutions**

Computer architecture exams can be daunting encompassing a vast landscape of concepts from instruction sets to memory hierarchies. This article aims to equip you with the knowledge and strategies to tackle common exam questions providing both in-depth explanations and practical solutions. We'll cover key areas offering examples and highlighting crucial understanding.

## I Instruction Set Architecture (ISA)

ISA questions often focus on understanding how instructions are fetched, decoded, and executed. They might involve analyzing assembly code, calculating instruction cycle times, or comparing different ISA designs.

### Common Question Types

#### Assembly Language Programming

Translate high-level code snippets into assembly language considering register allocation and memory addressing modes.

#### Instruction Pipelining

Analyze the performance implications of pipeline hazards: data hazards, control hazards, structural hazards, and describe solutions like forwarding and branch prediction.

#### RISC vs CISC

Compare and contrast Reduced Instruction Set Computer (RISC) and Complex Instruction Set Computer (CISC) architectures highlighting their advantages and disadvantages.

**Example Question:** Write an assembly program to add two numbers stored in memory locations A and B, storing the result in C. Assume a simple ISA with LOAD, ADD, and STORE instructions.

**Solution (assembly):**

```
LOAD R1, A      ; Load the value at memory location A into register R1
LOAD R2, B      ; Load the value at memory location B into register R2
ADD R3, R1, R2   ; Add the values in R1 and R2, storing the result in R3
STORE R3, C      ; Store the value in R3 into memory location C
```

This simple example showcases the fundamental operations involved in assembly programming. More complex questions might involve loops, conditional statements, and function calls requiring a deeper understanding of stack operations and memory management.

## II Memory Hierarchy and Cache

Memory Understanding memory hierarchy is crucial. Questions frequently explore cache organization, replacement policies, and performance analysis.

### Common Question Types

#### Cache Mapping

Describe different cache mapping techniques: direct-mapped, associative, set-associative, and their impact on performance. Analyze hit and miss ratios.

#### Cache Replacement Policies

Explain various replacement algorithms: LRU, FIFO, random, and their effectiveness under different workload patterns.

#### Memory Performance

Calculate effective memory access time considering cache hit rates and memory access times.

**Example Question:** A system has a cache with a hit rate of 90%. The cache access time is 10 ns, and the main memory access time is 100 ns. Calculate the average memory access time (AMAT).

**Solution:**

Access Type	Hit Rate	Access Time (ns)
Cache Hit	0.9	10
Cache Miss	0.1	100

AMAT = Hit Rate \* Cache Access Time + Miss Rate \* Main Memory Access Time

AMAT =  $0.9 \times 10 \text{ ns} + 0.1 \times 100 \text{ ns} = 9 \text{ ns} + 10 \text{ ns} = 19 \text{ ns}$

## III Pipelining and Parallelism

Pipelining and parallel processing are vital for enhancing computer performance. Exam questions might involve analyzing pipeline stages, identifying hazards, or comparing different parallel architectures.

### Common Question Types

#### Pipeline Stages

Describe the different stages of a typical instruction pipeline: fetch, decode, execute, memory access, write back, and explain how they contribute to performance.

#### Pipeline Hazards

Identify and explain the different types of pipeline hazards and propose

solutions to mitigate their impact

### 3 Parallel Architectures

Compare different parallel architectures eg SIMD MIMD and discuss their strengths and weaknesses

**Example Question** Explain how branch prediction improves pipeline performance

**Solution** Branch prediction attempts to anticipate the outcome of a branch instruction before its actually executed If the prediction is correct the pipeline can continue fetching and executing instructions along the predicted path avoiding stalls Incorrect predictions result in pipeline flushes but overall accurate branch prediction significantly reduces pipeline stalls and improves performance

### IV InputOutput IO Systems

IO systems are often examined through questions relating to IO devices interrupts and DMA

**Common Question Types**

#### Interrupt Handling

Explain the interrupt handling process including how interrupts are generated handled by the CPU and returned to the main program flow

#### DMA

Describe the function of Direct Memory Access DMA and how it improves IO performance

#### IO Controllers

Explain the role of IO controllers in managing communication between the CPU and peripheral devices

### V Multiprocessors and Multicore Systems

Understanding multiprocessor and multicore architectures is increasingly important Expect questions on various aspects of parallel processing and synchronization

**Common Question Types**

#### Multiprocessor Architectures

Compare different multiprocessor architectures eg shared memory distributed memory and their advantages and disadvantages

#### Synchronization Techniques

Explain different synchronization techniques eg semaphores mutexes monitors used to coordinate access to shared resources in multiprocessor systems

#### Cache Coherence

Describe cache coherence problems and solutions eg snooping protocols directorybased protocols in sharedmemory multiprocessor systems

### Key Takeaways

Master the fundamentals of ISA including assembly programming and instruction execution Develop a strong understanding of memory hierarchy including caching and virtual memory

### 4 Thoroughly grasp pipelining and parallel processing concepts

Familiarize yourself with IO systems and interrupt handling Understand the principles of multiprocessor and multicore architectures

### Frequently Asked Questions FAQs

#### 1 What is the best way to prepare for a computer architecture exam

Practice solving a variety of problems focusing on understanding the underlying concepts rather than rote memorization Utilize textbooks online resources and past exam papers

#### 2 How important is understanding assembly language

While not always heavily weighted understanding assembly language provides a crucial foundation for grasping how instructions are executed and how the CPU interacts with memory

#### 3 What are the most common mistakes students make on computer architecture exams

Common mistakes include failing to understand the implications of different cache replacement policies misinterpreting pipeline hazards and neglecting the intricacies of synchronization techniques in multiprocessor systems

#### 4 How can I improve my problemsolving skills in computer architecture

Work through numerous examples and practice problems Start with simpler problems and gradually progress to more complex ones Dont be afraid to ask for help if you get stuck

#### 5 Are there any specific resources recommended for studying computer architecture

Several excellent textbooks are available along with online courses and tutorials Look for resources that provide clear explanations ample examples and practice problems Remember to tailor your resources to the specific syllabus and learning objectives of your course

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