

**VIT**

Vellore Institute of Technology

Slot: C2+TC2

**School of Computer Science Engineering and Information Systems****Winter Semester 2023-2024****Continuous Assessment Test – I****Programme Name & Branch: B.Tech – Information Technology****Course Name & code: Computer Architecture and Organization - BITE301L****Class Number (s): VL2023240503759, VL2023240503717, VL2023240503768****Faculty Name (s): (Dr. PRAVEEN KUMAR REDDY M, Dr. BALASUBRAMANI M, Dr. MEENATCHI S)****Exam Duration: 90 Min.****Maximum Marks: 50**

| Q.No. | Question                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Max Marks |
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| 1. ✓  | a) Assume that you are working with a computer system that has a byte-addressable memory, which is organized in 32-bit words. Each word in this memory consists of 4 bytes. You are tasked with handling a program that reads hexadecimal data entered through a keyboard. The hexadecimal data you have received is $(34128976)_{16}$ . You are instructed to store this hexadecimal data in successive byte locations in memory, starting at location 1000. Given the nature of data storage and retrieval, it is crucial to consider the format in which this data is stored. Show how this data would be represented in the computer's memory under both the big-endian and little-endian schemes? Provide the contents of the memory words for all the available locations. (5M)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 10        |
|       | b) Explain the fundamental differences between Reduced Instruction Set Computer (RISC) and Complex Instruction Set Computer (CISC) architectures? (5M)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |           |
| 2. ✓  | a) Assume you are a computer systems analyst tasked with evaluating the performance improvement of a new cache memory system in a computer processor. The current system accesses instructions from the main memory, but with the new cache, instructions can be accessed 30 times faster than main memory. Your job is to determine how much more efficient the system is with the cache compared to without cache. You know that the probability of finding a requested instruction in the cache is 0.94. If an instruction isn't in the cache, it needs to be fetched from the main memory, which adds extra time since it first goes to the cache and then to the processor. You are tasked with computing the speedup factor, which is the ratio of the program execution time without the cache to the execution time with the cache.<br>i. What is the speedup factor of the current system with the cache compared to without the cache? (2.5M)<br>ii. For the second part of your task, the company is increasing three times the cache size. You are to predict the new speedup factor under the assumption that increasing three times the cache size. If the cache size increasing three times, leading to a reduced probability of cache misses, what will be the new speedup factor? (2.5M) | 10        |
|       | b) A CPU is driven by 4 GHz clock. Compute the duration of one clock cycle. Assume that on average the execution of an instruction takes 8 clock cycles. Compute the performance of the CPU in terms of MIPS (millions of instructions)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |

|       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |     |            |     |             |       |       |     |     |       |       |     |     |       |       |     |     |     |      |     |      |       |       |     |     |       |       |     |     |       |       |     |     |       |       |      |     |    |
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|       | per second). Assume that executing a specific program of 400 million instructions takes 2 seconds. How many clock cycles does it take on average to execute an instruction of this program? (5M)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |     |            |     |             |       |       |     |     |       |       |     |     |       |       |     |     |     |      |     |      |       |       |     |     |       |       |     |     |       |       |     |     |       |       |      |     |    |
| 3.    | You are working on a processor design and need to understand how the machine instruction "MUL R4, R2, R3" is executed. This instruction multiplies the contents of register R4 with the contents of register R2 and stores the result in register R3. The address of the memory location containing this instruction is initially in the Program Counter (PC). What are the detailed steps, including the data transfers and control commands, that the processor goes through to execute the instruction "MUL R4, R2, R3", starting from the point where the address of the instruction is in the PC? (10M)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 10  |            |     |             |       |       |     |     |       |       |     |     |       |       |     |     |     |      |     |      |       |       |     |     |       |       |     |     |       |       |     |     |       |       |      |     |    |
| 4.    | <table border="1"> <tr><td>300</td><td>LOAD to AC</td></tr> <tr><td>301</td><td>Address=500</td></tr> <tr><td>.....</td><td>.....</td></tr> <tr><td>399</td><td>600</td></tr> <tr><td>.....</td><td>.....</td></tr> <tr><td>500</td><td>600</td></tr> <tr><td>.....</td><td>.....</td></tr> <tr><td>599</td><td>780</td></tr> <tr><td>600</td><td>1000</td></tr> <tr><td>601</td><td>2000</td></tr> <tr><td>.....</td><td>.....</td></tr> <tr><td>700</td><td>650</td></tr> <tr><td>.....</td><td>.....</td></tr> <tr><td>800</td><td>800</td></tr> <tr><td>.....</td><td>.....</td></tr> <tr><td>900</td><td>660</td></tr> <tr><td>.....</td><td>.....</td></tr> <tr><td>1000</td><td>650</td></tr> </table> <p>XR=100, PC=300, R1=600, consider the memory locations and registers, evaluate the effective address and the content of AC if the addressing mode of the instruction is</p> <ol style="list-style-type: none"> <li>1. Direct</li> <li>2. Indirect</li> <li>3. Register Direct</li> <li>4. Register Indirect</li> <li>5. Immediate</li> <li>6. Relative</li> <li>7. Indexed</li> <li>8. Base with Index</li> <li>9. Auto increment</li> <li>10. Auto Decrement</li> </ol> | 300 | LOAD to AC | 301 | Address=500 | ..... | ..... | 399 | 600 | ..... | ..... | 500 | 600 | ..... | ..... | 599 | 780 | 600 | 1000 | 601 | 2000 | ..... | ..... | 700 | 650 | ..... | ..... | 800 | 800 | ..... | ..... | 900 | 660 | ..... | ..... | 1000 | 650 | 10 |
| 300   | LOAD to AC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |     |            |     |             |       |       |     |     |       |       |     |     |       |       |     |     |     |      |     |      |       |       |     |     |       |       |     |     |       |       |     |     |       |       |      |     |    |
| 301   | Address=500                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |     |            |     |             |       |       |     |     |       |       |     |     |       |       |     |     |     |      |     |      |       |       |     |     |       |       |     |     |       |       |     |     |       |       |      |     |    |
| ..... | .....                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |     |            |     |             |       |       |     |     |       |       |     |     |       |       |     |     |     |      |     |      |       |       |     |     |       |       |     |     |       |       |     |     |       |       |      |     |    |
| 399   | 600                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |     |            |     |             |       |       |     |     |       |       |     |     |       |       |     |     |     |      |     |      |       |       |     |     |       |       |     |     |       |       |     |     |       |       |      |     |    |
| ..... | .....                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |     |            |     |             |       |       |     |     |       |       |     |     |       |       |     |     |     |      |     |      |       |       |     |     |       |       |     |     |       |       |     |     |       |       |      |     |    |
| 500   | 600                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |     |            |     |             |       |       |     |     |       |       |     |     |       |       |     |     |     |      |     |      |       |       |     |     |       |       |     |     |       |       |     |     |       |       |      |     |    |
| ..... | .....                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |     |            |     |             |       |       |     |     |       |       |     |     |       |       |     |     |     |      |     |      |       |       |     |     |       |       |     |     |       |       |     |     |       |       |      |     |    |
| 599   | 780                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |     |            |     |             |       |       |     |     |       |       |     |     |       |       |     |     |     |      |     |      |       |       |     |     |       |       |     |     |       |       |     |     |       |       |      |     |    |
| 600   | 1000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |     |            |     |             |       |       |     |     |       |       |     |     |       |       |     |     |     |      |     |      |       |       |     |     |       |       |     |     |       |       |     |     |       |       |      |     |    |
| 601   | 2000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |     |            |     |             |       |       |     |     |       |       |     |     |       |       |     |     |     |      |     |      |       |       |     |     |       |       |     |     |       |       |     |     |       |       |      |     |    |
| ..... | .....                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |     |            |     |             |       |       |     |     |       |       |     |     |       |       |     |     |     |      |     |      |       |       |     |     |       |       |     |     |       |       |     |     |       |       |      |     |    |
| 700   | 650                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |     |            |     |             |       |       |     |     |       |       |     |     |       |       |     |     |     |      |     |      |       |       |     |     |       |       |     |     |       |       |     |     |       |       |      |     |    |
| ..... | .....                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |     |            |     |             |       |       |     |     |       |       |     |     |       |       |     |     |     |      |     |      |       |       |     |     |       |       |     |     |       |       |     |     |       |       |      |     |    |
| 800   | 800                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |     |            |     |             |       |       |     |     |       |       |     |     |       |       |     |     |     |      |     |      |       |       |     |     |       |       |     |     |       |       |     |     |       |       |      |     |    |
| ..... | .....                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |     |            |     |             |       |       |     |     |       |       |     |     |       |       |     |     |     |      |     |      |       |       |     |     |       |       |     |     |       |       |     |     |       |       |      |     |    |
| 900   | 660                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |     |            |     |             |       |       |     |     |       |       |     |     |       |       |     |     |     |      |     |      |       |       |     |     |       |       |     |     |       |       |     |     |       |       |      |     |    |
| ..... | .....                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |     |            |     |             |       |       |     |     |       |       |     |     |       |       |     |     |     |      |     |      |       |       |     |     |       |       |     |     |       |       |     |     |       |       |      |     |    |
| 1000  | 650                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |     |            |     |             |       |       |     |     |       |       |     |     |       |       |     |     |     |      |     |      |       |       |     |     |       |       |     |     |       |       |     |     |       |       |      |     |    |
| 5.    | <p>a. Write the 3-address, 2-address, 1-address instruction format for the given instruction <math>S=(P*Q)/(R-M)</math>. (5M)</p> <p>b. Calculate the result of the addition operation using signed 2's complement binary representation with eight bits for each number. Determine if an overflow occurs in each case. (5M)</p> <ol style="list-style-type: none"> <li>1. <math>(+50) + (-55)</math></li> <li>2. <math>(-34) + (-38)</math></li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 10  |            |     |             |       |       |     |     |       |       |     |     |       |       |     |     |     |      |     |      |       |       |     |     |       |       |     |     |       |       |     |     |       |       |      |     |    |