



# Daffodil International University

Faculty of Science & Information Technology

Department of Computer Science & Engineering

Final Examination, Summer 2025

Course Code: CSE413 Course Title: Computer Architecture and Organization

Level:3 Term:1 Batch:64

Time: 2:00 Hrs

Marks: 40

**Answer ALL the Questions**

*[The figures in the right margin indicate the full marks and corresponding course outcomes]*

1.	a)	A computer engineering student is working on designing a custom embedded processor for a robotics project. While testing mathematical operations for sensor data processing, she realizes that complex operations are significantly slowing down the main processor.  What could be a suitable solution to offload complex operations from the main processor by <b>explaining the concept</b> and working principle of that solution.	[3]	CO2
	b)	Using the long division (paper-pencil) method, divide the binary number $1110_2$ by $10_2$ . <b>Show</b> the division process clearly, including subtraction steps at each stage. Provide the final products: <b>Quotient</b> and <b>Remainder</b> .	[3]	
2.	a)	From the below instructions <b>identify</b> what kind of data hazards are happening there in the timing diagram of five stages (FI, DI, FO, EI, WO). Justify your answer by performing all the instructions together on a <b>single timing diagram</b> . Finally <b>show one solution</b> timing diagram to <b>avoid</b> the particular hazards that occurred.  Initially assume, $ST0 = 5$ , $ST1 = 10$  I1: ADD $ST2, ST0, ST1$ // $T2 = T0 + T1$ I2: MUL $ST3, ST2, 2$ I3: ADD $ST4, ST0, ST3$ I4: SUB $ST1, ST4, ST2$ // $T1 = T4 - T2$ I5: MUL $ST2, ST0, ST1$	[3+4]	CO3
	b)	A student is analyzing the behavior of a <b>5-stage instruction pipeline</b> in a modern processor. The program being executed consists of <b>15 instructions</b> . The pipeline encounters <b>two conditional branches</b> : <ul style="list-style-type: none"><li>• <b>First Branch:</b> After <b>Instruction-4</b>, where <b>Instruction-12</b> should execute only if the branch is taken.</li><li>• <b>Second Branch:</b> After <b>Instruction-12</b>, where <b>Instruction-6</b> should execute only if this branch is taken.</li></ul> <b>Illustrate</b> the effect of both branches on the pipeline operation using a <b>single timing diagram</b> and <b>discuss</b> the impact on instruction flow	[5]	

3.	a)	A computing device is being designed to handle large-scale data processing efficiently. This system uses a <b>cache</b> of size <b>32,768 bits</b> and a <b>RAM</b> of size <b>32 KB</b> and a <b>block size</b> of <b>64 bytes</b> , and each byte needs a unique address for address translation. At the initial design phase, a <b>direct mapped</b> cache is used.  <b>Sketch</b> the Cache and RAM structure with calculated blocks for the above requirements.  <b>Show</b> the direct mapping diagram on that same structure using the law $(k \text{ mod } n)$ where $k$ represents corresponding block number in RAM and $n$ represents total number of lines in cache with address translation.	[4+3]	CO4
	b)	i. <b>Find</b> out the percentage of data loss possibility of cache memory in detail for the above structure with direct mapping.  ii. <b>How</b> you will reduce the data loss to 75% for the above scenario by updating the size of the single cache.	[4+3]	
4.	a)	You are playing a <b>128 GB</b> open-world game, on your computer that has only 8 GB of RAM. Along with the game, a Chrome tab is open for a walkthrough guide, and two PDFs are running in the background. Still, your system performs without crashing or freezing.  <b>Identify</b> the memory management technique and type of memory that supports this and <b>illustrate</b> how the system can run such a high-memory-demanding game with limited physical RAM with diagram.	[4]	
	b)	Assume a specific game map section is not found in that special memory when requested during gameplay. <b>Describe</b> what the operating system does when a required portion of the game data is not present in that memory.	[4]	