

ACOL 216: Introduction to Computer Architecture

IIT Delhi – Abu Dhabi
Semester II, 2025–26

Assignment 1: RISC-Tac-Toe

Due Date: March 7, 2026

Total Marks: 50

Overview

In this assignment, you will design and implement a complete **Tic-Tac-Toe State Verifier** for a generalized 6×6 board using the **SimpleRISC assembly language**. Your program will be given a **snapshot of a game state** via memory and must determine whether the state is **legal or illegal**. If the state is legal, the program must further determine whether the game outcome is a **win for Player 1**, **win for Player 2**, or a **draw**.

All inputs are provided before execution begins, and the program must produce a single deterministic output value. The assignment emphasizes low-level algorithm design, correctness reasoning, memory discipline, and exhaustive handling of edge cases under architectural constraints.

This assignment contributes **10%** to the course total.

Game Description

The game board is a fixed-size 6×6 grid. Each cell of the grid may contain one of the following values:

- **0** → empty cell,
- **1** → marker placed by Player 1,
- **2** → marker placed by Player 2.

Player 1 always moves first. Players alternate turns thereafter.

The provided game state represents a snapshot after an arbitrary number of moves. The program must infer legality and outcome solely from this snapshot.

Board Representation

The board is stored in memory in **row-major order**. Each cell occupies one memory word.

Let (i, j) denote the cell at row i and column j , where $0 \leq i, j < 6$. The memory address of cell (i, j) is computed as:

$$\text{base} + 4 \times (6i + j)$$

You must compute all indices algorithmically. Hardcoding cell addresses or winning patterns is not permitted.

Input Specification

All input is provided **before execution begins** through predefined memory locations. Input memory must not be modified.

Board State

A contiguous memory region contains exactly 36 words representing the 6×6 board snapshot. Each word stores one of the values $\{0, 1, 2\}$. No additional input will be provided.

Legality Rules

A board state is considered **legal if and only if all** of the following conditions hold:

1. Every cell contains only one of the values $\{0, 1, 2\}$.
2. The number of Player 1 markers is either equal to or exactly one greater than the number of Player 2 markers.
3. Player 2 cannot have more markers than Player 1.
4. Both players cannot simultaneously satisfy a winning condition.

If any of the above rules is violated, the state is **illegal**.

Winning Conditions

A player is declared a winner if the board contains **any contiguous sequence** of that player's markers of length:

3, 4, 5, *or* 6

in any of the following directions:

- horizontal,
- vertical,
- main diagonal,
- anti-diagonal.

All win detection must be performed algorithmically using loops and conditional branching. Hardcoding specific winning positions or patterns is not allowed. If both players satisfy a winning condition, the state is illegal.

Draw Condition

A board state is a **draw** if:

- the state is legal,
- neither player satisfies a winning condition.

There is no requirement that the board be completely filled for a draw.

Arithmetic Requirement

The SimpleRISC architecture does not provide hardware multiplication. You must therefore implement multiplication in software and use it for all index computations involving row and column calculations. The multiplication logic must be correct, reusable, and must not corrupt global program state.

Output Specification

At termination, your program must write exactly one integer value to the designated output memory location:

- **-1** : illegal state,
- **0** : legal state and draw,
- **1** : Player 1 wins,
- **2** : Player 2 wins.

Any other output value is considered incorrect.

Memory Interface Specification

This assignment will be **automatically graded**. All memory locations described below will be initialized by the grader before execution.

Input Memory

- **Board Base Address:** A fixed memory address marks the start of the 6×6 board state.

Input memory must not be overwritten.

Output Memory

- **Result Location:** A single designated memory location must be written exactly once with the final outcome.

No other memory locations will be inspected during grading.

Submission Instructions

This assignment must be completed **individually**.

Submit a single compressed file named:

`<entry_number>.zip`

Upon extraction, the archive must create a directory named `<entry_number>/` containing:

- `solution.asm` — the complete SimpleRISC implementation,
- `report.pdf` — a technical report (maximum **2 pages**) describing the design, memory layout, and correctness arguments.

No additional files or directories are permitted.

Evaluation Rubric

The assignment will be evaluated out of **50 marks**, based on how many test cases your program passes successfully during the evaluation. The exact number of test cases and marks for each will be disclosed later. **5 marks** are also reserved for the clarity of the report; however, the report will not compensate for incorrect program behaviour.

Academic Integrity

This assignment must be completed individually. Plagiarism in any form will result in **zero marks** for the assignment. We will use automated tools such as **MOSS** for plagiarism detection and **GPTZero** (or similar tools) for detecting inappropriate use of AI-based systems. Severe cases may attract additional penalties, including disciplinary action as per institute norms. If you are unsure whether a particular form of assistance is permitted, seek clarification before submission.

Important Notes

- **The process to install the SimpleRISC emulator and run the assembly programs on it will be demonstrated in the Tutorial sessions.**
- The assignment is strictly auto-graded.
- Correctness must hold for *all* legal board configurations.
- Incremental or ad-hoc coding approaches are unlikely to succeed.