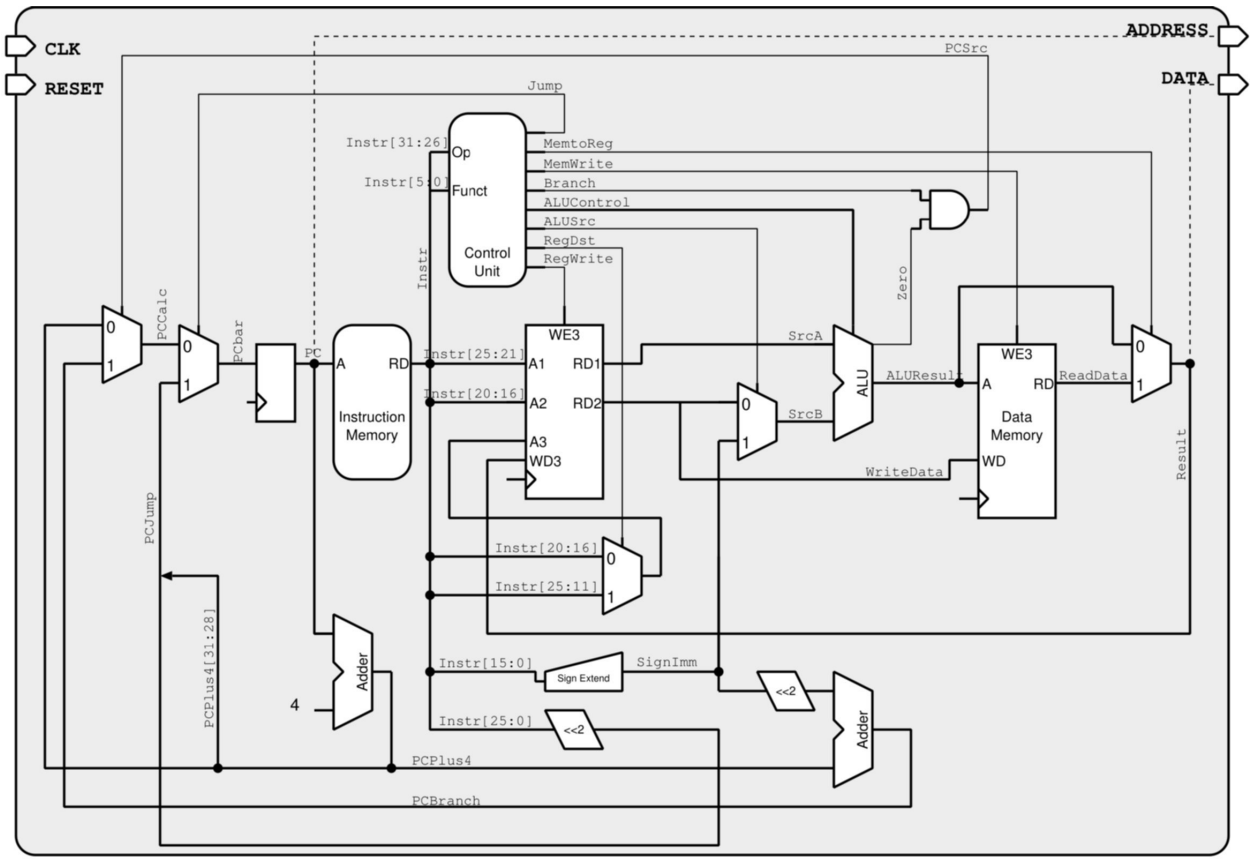
6. The figure below is the block diagram of the MIPS process that you have designed during the laboratory exercises.



It turns out that this processor is **not fast enough** for a project that you want to do. You are in a meeting to discuss what can be done to improve the performance of this processor. Your colleagues have made the following suggestions. For each suggestion, first state whether or not the idea will work, and then *briefly* explain why.

(a) (2½ points) Alice: "Let us add a cache to the system. This will reduce the average memory access time, and make the processor faster, as it will spend less time to access memory":

Solution: This idea **does not work**. While the statement is true in general, the processor that is used in the exercise already has 1 clock cyle access time. This can not be reduced further. No matter what caching system is used, the memory access will still be the same.

(b) (2½ points) Bob: "We can use a pipelined architecture. The pipeline stages will reduce the critical path and allow a higher clock rate to be used"

Solution: This idea **could work**. One of the limiting factors in the processor speed is the critical path. By inserting pipeline registers the critical path can be shortened, and the processor can be operated at a higher frequency. Provided that hazards associated with a pipelined architecture can be handled, this idea would work.

(c) (2½ points) Charlie: "The processor in the exercise uses a single cycle. This means that it uses 1 CPI (cycles per instruction). I propose using a five-cycle architecture. In this case the processor will use 5 CPI, and will be faster."

Solution: This idea **does not work**. The speed of the processor depends on the clock cycle time. If the cycle time is the same than a processor that uses 5 CPI is 5 times slower than a processor that uses 1 CPI. A multi-cycle processor can only be faster if the reduction in the clock cycle time is more than the increase in the average CPI. In general this is not possible. Multi-cycle processors are mostly used to share expensive resources (memories, adders).

(d) (2½ points) Diane: "Since we are not limited by area or power, how about using a multi-processor system using 2 processors in parallel rather than a single processor?"

Solution: This idea **could work**. In theory 2 processors would be twoce as fast as a single processor. However, there are not many problems that have a fully parallelized solution where two proecssors can work independently. Data dependency may reduce the efficiency of parallelization, but in general the idea would increase the performance.