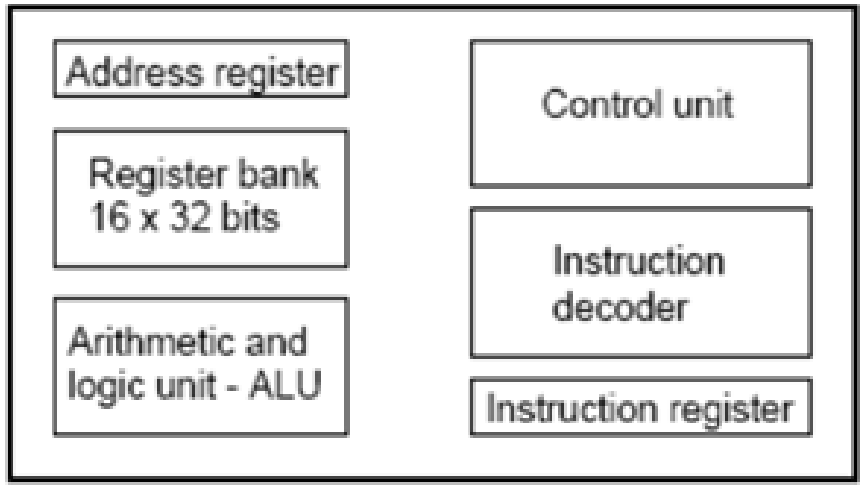
Revision Class 2

14th May 2019

Question

- Draw a block diagram of an ARM 7 microprocessor and fully describe the function of each block.

Answer:



Instruction register: The instructions stored in memory travel along the data bus to the CPU where they are loaded into the instruction register.

The instructions are in 'machine code' and the instruction decoder determines the function of each instruction. The instruction decoder and control unit determine what the other parts of the CPU do. The control unit is also in charge of the control bus.

The arithmetic and logic unit (ALU) performs the mathematical functions as required.

The register bank is a local memory for the CPU. They are used to hold data which is processed by the ALU and also hold the results of any calculation.

The address register is a 32 bit memory device which holds a memory address value. Stores the address to which data will be retrieved or sent.

Fetch Decode and Execute

- The CPU performs three cycles sequentially; fetch, decode, execute.
- During the fetch cycle an instruction in memory is loaded into the instruction register;
- During the decode cycle the instruction is interpreted by the instruction decoder;
- During the execute cycle, either the ALU performs a calculation on values held in registers, a value in a register is stored into memory, or a value in memory is loaded into a register

Program counter

The CPU needs to know the memory address of the next instruction to be executed.

This is always held in the program counter, which in the ARM processor is always register r15.

Stack and Stack Pointer

- If one subroutine calls another subroutine, [for example within subroutine A, subroutine B is called], the link register cannot store the return address for both subroutines at the same time. The overcome this problem a stack is used to preserve the return address of all subroutines.
- The stack pointer identifies the top of the stack which is a dynamic memory structure used to hold the return addresses for subroutines

Flags

- The negative flag, N, is set when the most significant bit of the 32 bit result is 1.
- The zero flag, Z, is set when the result (not including any carry out) is zero.
- The carry flag will be set if the sum is greater than 0xFFFFFFFF. (carry into 33^{rd} bit)
- The overflow flag, V, is set when the result, represented as a two's compliment number, is greater than $(2^{31} - 1)$ or less than -2^{31} .
- Flags are used to indicate if an event has happened. They can be used to determine if another instruction has executed or not, called conditional executions. [The carry flag can also be used in arithmetic functions]. Conditional executions can be used in branch instructions, to decide if the conditions are correct for branching.

Cache Memory

- The microprocessor may be executing one instruction every 5 nanoseconds or less. This causes problems because if it is connected to a large memory it would require a very fast access time. The key is to use a memory cache. This is a small fast on chip memory that holds the most recently accessed data from the main memory.