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Lab 4

Theory

1.

1.1. ROM stands for read-only memory, which is a storage that is used to permanently store data on computers and other electronic devices.

1.2. RAM is a form of computer memory that can be read and changed in any order, typically used to store working data and machine code. On the other hand, ROM can only store unchangeable data.

1.3 Differences between SRAM and DRAM

SRAM	**DRAM**
Stores information as long as the power is supplied	Stores information as long as the power is supplied or a few milliseconds when power is switched off
Transistors are used to store information in SRAM	Capacitors are used to store data in DRAM
Capacitors are not used hence no refreshing is required	To store information for a longer time, contents of the capacitor needs to be refreshed periodically
Fast access speed	Slow access speed
Does not have a refreshing unit	Has a refreshing unit
Expensive	Cheap
Low-density device	High-density device
Bits are stored in voltage form	Bits are stored in the form of electric energy
Used in cache memories	Used in main memories
Consumes less power and generates less heat	Uses more power and generates more heat

1.4.

- USB thumb drives typically use flash memory (EEPROM)
- We shouldn't rely on this for critical data storage because
    - **Editing ability:** The fundamental problem with most EEPROMs is the unreasonably long processing time required to alter memory bytes at a time. On the flash chip, a computer can read a specific byte from any address, but it can only delete and rewrite data in blocks.
    - **Lifetime:** The lifespan of flash memory is finite. The transistors gradually deteriorate when high voltage fields are applied, which causes the floating gates to operate more slowly.

2.
The number of bits needed to address all bytes in the system's RAM is:
1 GB = 2^(30) bytes
1 bytes = 8 = 2^(3) bits
=> We need 2^(30) * 2^(3) = 2^(30 + 3) = 2^(33) bits

3.
Von Neumann Architecture is a digital computer architecture whose design is based on the concept of stored program computers where program data and instruction data are stored in the same memory.
Harvard Architecture is the digital computer architecture whose design is based on the concept where there are separate storage and separate buses (signal path) for instruction and data.

Von Neumann Architecture	**Harvard Architecture**
Control bits and data bits share a common memory space/hardware.	Instructions and data are kept separate.
Allows processes to be interrupted (and stored as data) while higher priority tasks are executed, and then restored and resumed.	Reasonably immune to buffer overflow attacks.
Requires the use of a stack. But stacks can be implemented in software as well as hardware.	Used in PIC controllers, digital signal processors where memory is scarce and speed is important.
Common bus for data and instruction transfer.	Data bus and control buses can be different widths, types.
Run faster and more secure.	Run slower and less secure.
More expensive, less extensible.	Less expensive, more extensible.

4.

- Cache is the temporary memory officially termed “CPU cache memory”.
- Temporarily stores frequently used instructions and data for quicker processing by the central processing unit (CPU) of a computer.

5.

- An interrupt is a response to a signal that needs attention from the software.
- 4 common types of interrupt
    - Hardware Interrupt
    - Software Interrupt
    - Level-triggered Interrupt
    - System Implementation

5.1.

- Polling is an alternative approach to interrupts. It checks the state/input of each hardware device in a predefined sequence: process any change/input as needed.
- Polling is not commonly used because it
    - Can waste time checking hardware which is doing nothing.
    - Doesn't take advantage of the stack.
    - If one device freezes, this can make the entire computer unresponsive.

6.

- A stack is a conceptual structure consisting of a set of homogeneous elements and is based on the principle of last in first out (LIFO).
- The stack concept is used in programming and memory organization in computers.

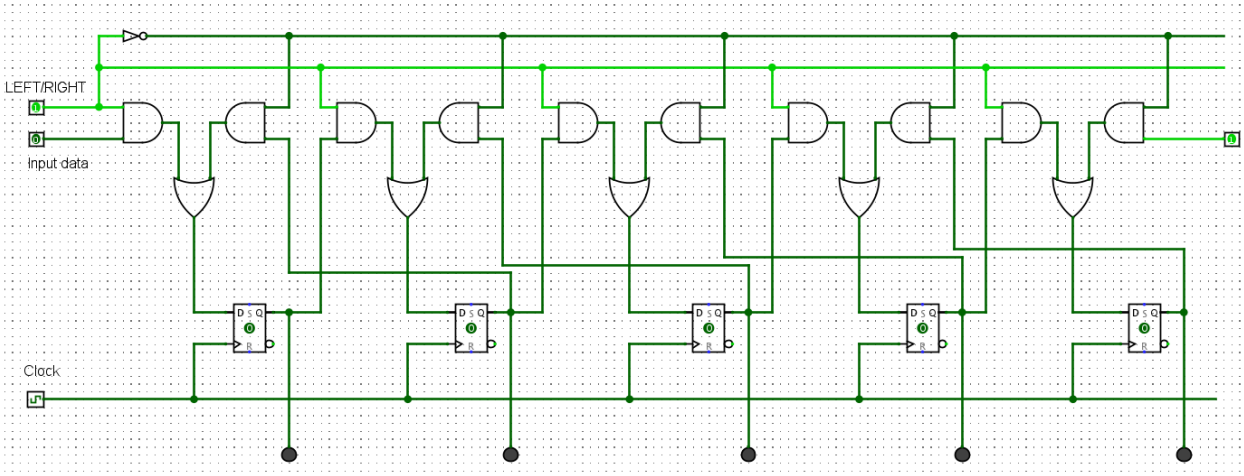
6.1. In contrast to the regular kernel stack that is allocated per process, the two additional stacks are allocated per CPU. Whenever a hardware interrupt occurs (or a softIRQ is processed), the kernel needs to switch to the appropriate stack.

6.2. Application of Stack Data Structure:

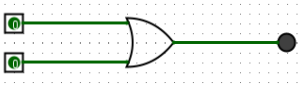
- Stack is used for evaluating expressions with operands and operations.
- Matching tags in HTML and XML
- Undo function in any text editor.
- Infix to Postfix conversion.
- Stacks are used for backtracking and parenthesis matching.
- Stacks are used for conversion of one arithmetic notation to another arithmetic notation.
- Stacks are useful for function calls, storing the activation records and deleting them after returning from the function. It is very useful in processing the function calls.
- Stacks help in reversing any set of data or strings.

Practical

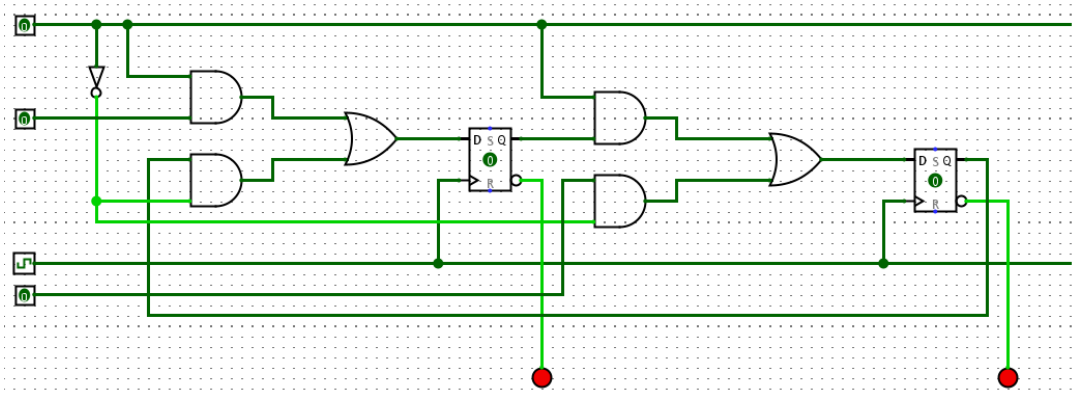
5-bit deep, 1-bit wide stack



2-bit encoder



Bi-directional shifting stack



Parallel stack