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Class: Computer Systems (Thursday afternoon)

Title: Lab 4

1.1 – ROM (Read-only memory) is a type of memory in which data is loaded during manufacturing and cannot be modified afterwards by the user. It is used to store software that will not be changed during the lifetime of the system.

1.2 – RAM (Random access memory) is a type of memory which supports both read and write operations. The key difference between RAM and ROM is that ROM is read-only.

1.3 – Static RAM is fast and keeps its data as long as it is powered. However, it is expensive and requires more electrical components to build. Dynamic RAM, on the other hand, retains data as long as it is frequently refreshed. It is slower than static RAM but is much cheaper and easier to build.

1.4 – In USB thumb drives, flash memory (EEPROM) is often used. These devices are unreliable for critical data storage because one of their physical components (a barrier layer) gets damaged on every write operation, therefore limiting their number of maximum writes.

2 – 1 GB of memory is the equivalent of 1024^3 bytes of memory. To address every byte, a total of 1024^3 unique binary addresses are needed. The number of bits needed to represent 1024^3 possible addresses is $\lceil \log_2 1024^3 \rceil = 30$ bits.

3 – Both the Von Neumann and Harvard computer architectures consist of input/output devices and a central processing unit reading from and writing to a memory unit. However, the key difference between the two is that the Von Neumann architecture stores both instructions and data in the same memory space while the Harvard architecture separate them into different spaces. The Von Neumann architecture supports the interruption of processes with the use of a stack. The Harvard architecture offers speed and security and is used in space-limited PIC controllers which require speed.

4 – Cache memory is a type of temporary memory used to store frequently accessed data and instructions needed by the CPU. Its purpose is to speed up the delivery of this data so that the CPU can perform faster.

5 – An interrupt is a signal from a device attached to a computer or a program running on that computer which causes the CPU to temporarily stop what it is

doing and switch to another task. Four common types of interrupt signals (INTs) are clock INTs, keyboard/mouse INTs, error INTs and network INTs.

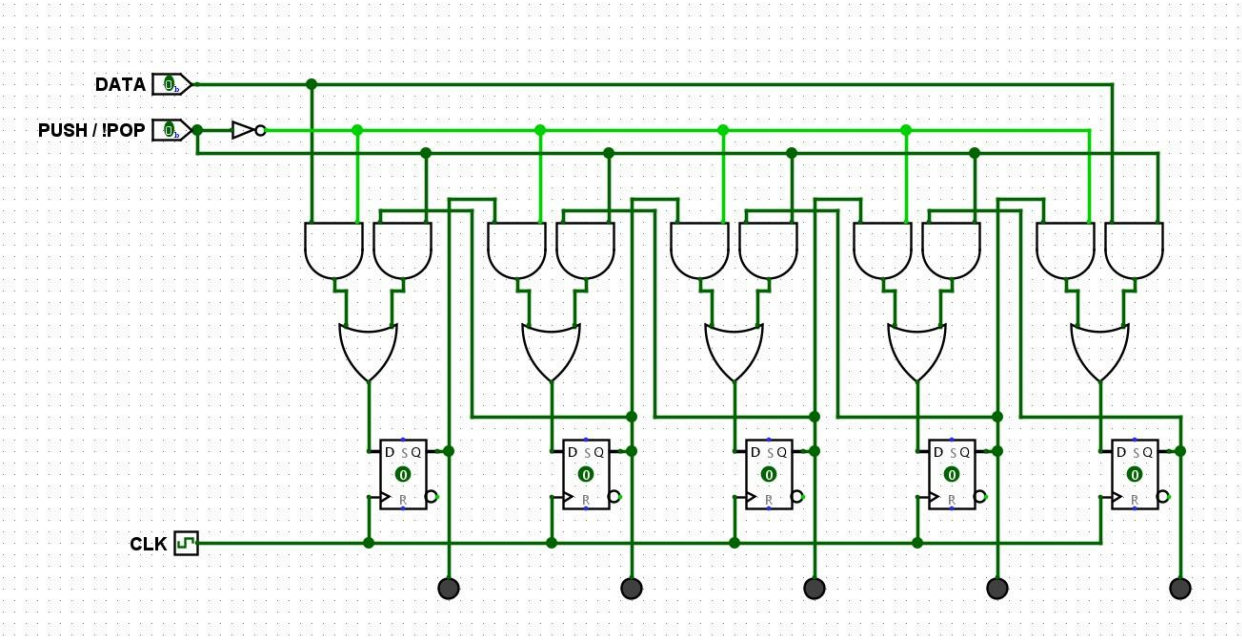
5.1 – Polling is a process where the devices connected to a computer have their states checked continuously in a pre-defined order to see if anything needs to be handled. It is not commonly used because it wastes time checking devices that are not running, fails to leverage the stack and freezes the entire system if one device freezes.

6 – A stack is a data structure in which whatever data goes in last comes out first. It supports two main operations: push, which adds data to the top of the stack, and pop, which reads data from the top of the stack. It allows one to access data without knowing the memory address of every byte.

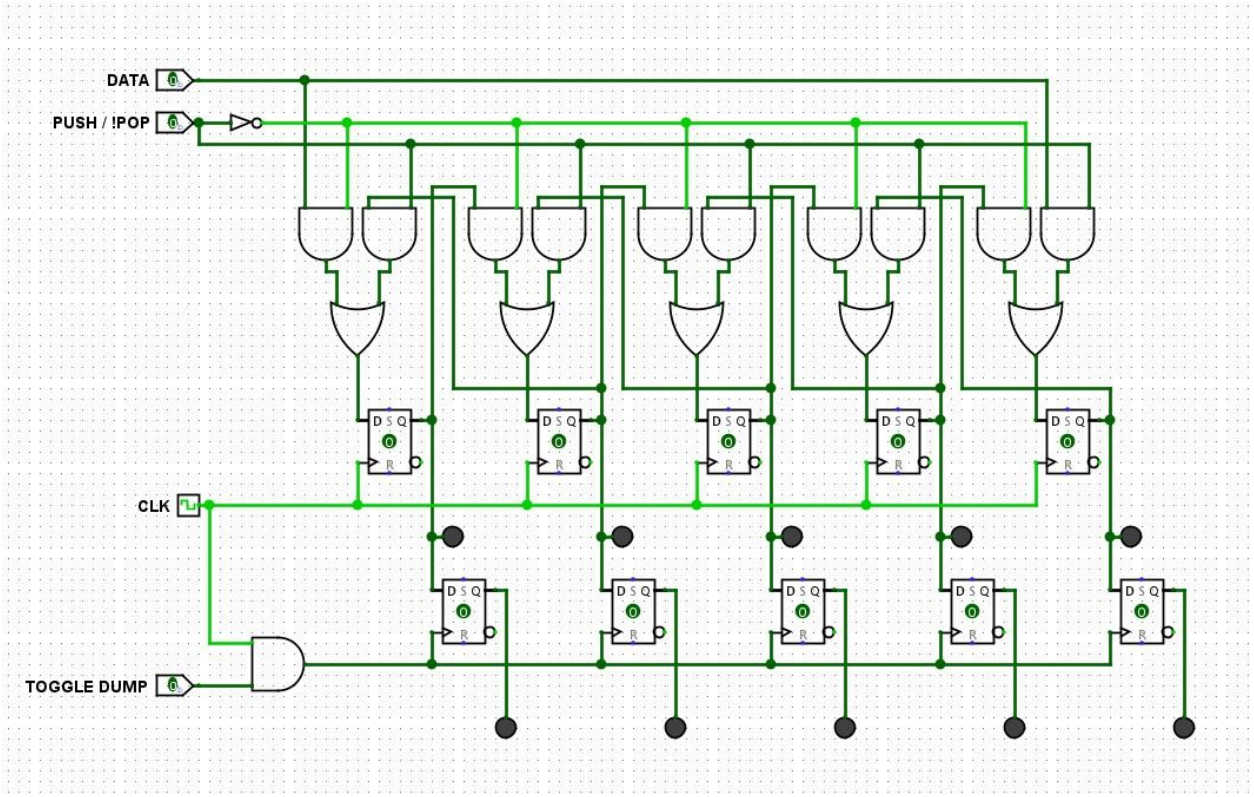
6.1 – Stacks are useful for handling interrupts because they provide a place for the CPU to store its current work before switching to another task. After the new task is completed, the CPU can pop data from the stack to resume its previous work.

6.2 – In programming, stacks are useful for storing all the data associated with a function call, especially when that function has to temporarily pause its execution to call other functions or itself.

7, 8, 9, 10, 11 – 5-bit deep, 1-bit wide stack



12 – 5-bit deep, 1-bit wide stack with stack dump


DATA
PUSH / !POP
CLK
TOGGLE DUMP
D S Q
R