Computer Systems Exam

May 26th, 2011

English version

**This is a closed book exam: no documentation is allowed.
Please make sure that your handwriting is readable!**

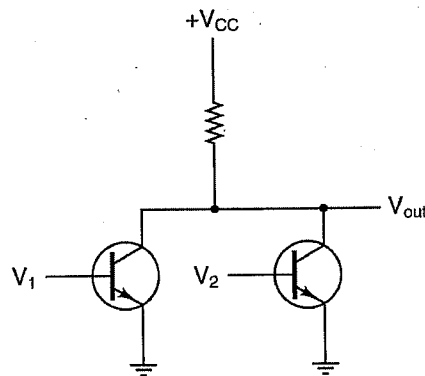**Note:** a Dutch version of this exam is also available, starting from page 5.

Q1. Encode this word using a Hamming code.
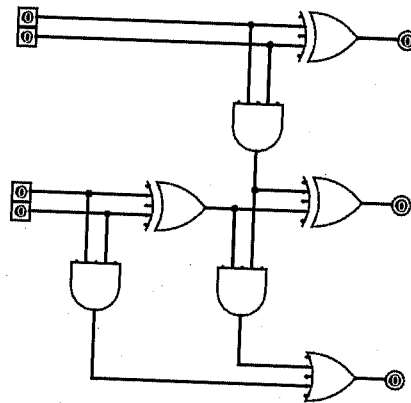
$$1101 \ 1101 \ 1101$$

Q2. Explain what is the memory wall, and what can be done about it.

Q3. How does Flash memory keep its value after the circuit is powered off?

Q4. Which digital gate is implemented by the following electronic circuit? Explain briefly how it works.
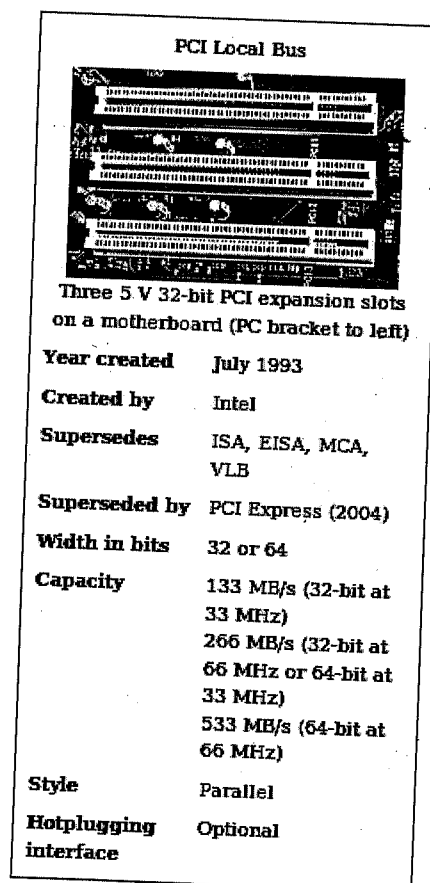
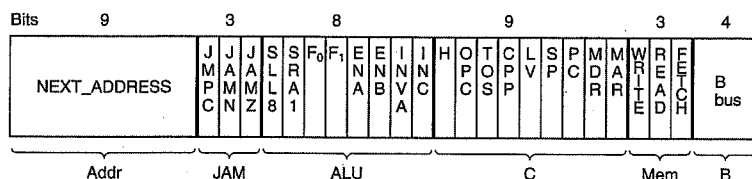Q5. What does the following digital circuit do?

Q6. Explain what is a Program Counter. Which layer of the computer architecture is in charge of updating it?

Q7. Explain the difference between a synchronous and an asynchronous bus.

Q8. Take a look at the following description of the PCI bus (copy-pasted from Wikipedia). Is PCI synchronous or asynchronous?

PCI Local Bus

Three 5 V 32-bit PCI expansion slots on a motherboard (PC bracket to left)

Year created	July 1993
Created by	Intel
Supersedes	ISA, EISA, MCA, VLB
Superseded by	PCI Express (2004)
Width in bits	32 or 64
Capacity	133 MB/s (32-bit at 33 MHz) 266 MB/s (32-bit at 66 MHz or 64-bit at 33 MHz) 533 MB/s (64-bit at 66 MHz)
Style	Parallel
Hotplugging interface	Optional

2

Q9. In the Mic1 microcode, it is impossible for two different micro-instructions A and B to have conditional branches to the same micro-instruction C. Explain why.

Q10. Micro-instructions in the Mic1 architecture are represented using 29 bits, as shown below.

Bits	9																											3	4
	NEXT_ADDRESS	JMPC	JAMN	JAMZ	SLL8	SRA1	F_0	F_1	ENA	ENB	INVA	INC	H	OPC	TOS	CPP	LV	SP	PC	MDR	MAR	WRITE	READ	FETCH					B bus

Addr — JAM — ALU — C — Mem — B

The Mic2 architecture extends Mic1 with a second input bus, an instruction fetch unit and an additional MBR2 register, but no pipelining. How many bits are necessary for a micro-instruction in the Mic2 architecture? Explain which bit(s) must be added or removed compared to Mic1.

Q11. What are the two types of locality properties? Explain how computer architectures exploit both types of locality to improve performance.

Q12. Give one example of an ISA instruction which should be available only when the CPU is running in privilege level 0.

Q13. Assume that a program's memory is as follows:

```
Variable A stored at address 120 contains value 150.
Variable B stored at address 130 contains value 140.
Variable C stored at address 140 contains value 130.
Variable D stored at address 150 contains value 120.
```

What will be the output of the following assembly instruction:

```
ADD #150,(D)
```

Q14. A user program issues the following operations:

- Read the content of a variable in memory; this variable contains a file name
- Open the file
- Read the first 1024 bytes of the file
- Check how many newlines are present in the content that has been read
- Display on screen: "The first 1024 bytes of this file contains X newlines" (where X is replaced with the right number)
- Close the file

How many system calls did the program issue? Give the full list.

Q15. Explain what is a race condition. What can be done about it?

Q16. A hard-disk has 300 tracks (numbered from 0 to 299). The disk is not being accessed at the moment. The arm is currently over track 59. Suddently, the disk driver receives a burst of requests for five blocks respectively located in tracks 12, 55, 70, 200 and 254.

   (a) In which orders will blocks be read if the driver implements the Shortest-Seek-Time-First policy?

   (b) In which orders will blocks be read if the driver implements the Scan policy?

Q17. A computer has 1 GB of physical memory. It runs a process which uses 1.5 GB of memory. Explain what happens when the program tries to access a variable which is currently not located in RAM:

   (a) What does the operating system do?

   (b) What does the MMU do?

Q18. In FAT-based file systems, each directory contains the meta-data of the files it contains (e.g., size, owner, date of the last update). Would it be a good idea to store this meta-data in a separate block per file, as inode-based file systems do?

Q19. A RAID-5 array contains 6 disks of 2 TB each. How much content can we store in it?

Q20. Why do libraries need to contain a symbol table? What does this table contain exactly?

— the end —