Computer Systems Exam

June 1st 2012 (8:45-11:30)

English version

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

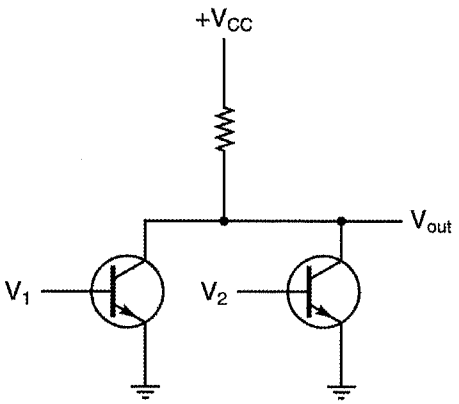
Note: a Dutch version of this exam is also available, starting from page 6.

Q1. This word has been encoded using a Hamming code. However, one bit is wrong. Which one?

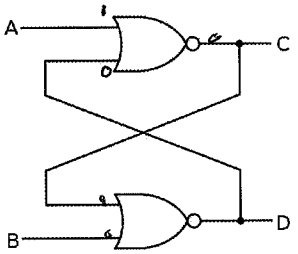
```
0011 1011 1101 1101 0
```

Q2. What is a superscalar CPU?

Q3. Which digital gate is implemented by the following electronic circuit? Explain briefly how it works.



Q4. How is this circuit called? Explain what it does and how it works.



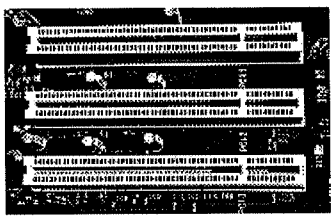
A=1 → C=0
B=0

Q5. Draw a digital logic circuit which implements the following truth table. You are authorized to use only basic gates: AND, OR, NOT.

Input A	Input B	Output
0	0	1
0	1	0
1	0	0
1	1	1

Q6. Take a look at the following description of the PCI bus (copy-pasted from Wikipedia). Is PCI synchronous or asynchronous?

PCI Local Bus



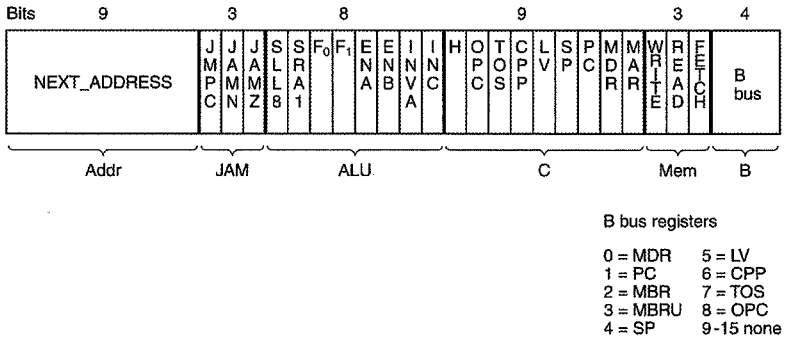
Three 5 V 32-bit PCI expansion slots on a motherboard (PC bracket to left)

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Superseded by	PCI Express (2004)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

Q7. What does the following micro-program do? Which IJVM instruction does it implement?

Main1	PC = PC + 1; fetch; goto (MBR)
xxx1	H = LV
xxx2	MAR = MBRU + H; rd
xxx3	MAR = SP = SP+1
xxx4	PC = PC+1; fetch; wr
xxx5	TOS = MDR; goto Main1

Q8. What is the binary representation of micro-instruction xxx3 from the previous question? The format of micro-instructions in the Mic1 machine is shown below. The xxx4 micro-instruction is located at address 65 in the control store.



Q9. What is the result of this computation expressed in reverse polish notation:
`8 2 5 * + 1 3 2 * + 4 - /`

Q10. A computer executes the following program:

```
int main () {
  int a, b;
  a = 8;
  b = 4;
  foo(a);
  return 0;
}

void foo (int x) {
  int c = 5;
  c = c+x;
}
```

Show the content of the stack while function `foo()` is executing (i.e., at line "`c=c+x;`").

Q11. 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 (C),B
```

Q12. A program carries out the following operations:

- Read one digit from the keyboard, store it in variable `k`.
- Read the value of variable `n` from memory
- Compute `k*n`
- Display the result of the multiplication on screen

Give the list of system calls that this process has issued. You can ignore the initialization and termination phases of the process.

Q13. What are the three main states that a process can have? Give the name of each state, and explain what this state corresponds to.

Q14. 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?

Q15. A disk driver is using the Scan policy for ordering I/O requests. In the recent past it has received the following list of requests that it didn't have time to serve:

- Read block 12
- Read block 832
- Read block 20
- Write block 721
- Read block 1
- Write block 552
- Write block 982
- Read block 500

The disk arm is currently in front of block 500. Give the order in which the disk driver will process these requests. If there are multiple possible answers, give the full list of correct answers.

Q16. Why do programmers need to explicitly open a file before they can read it? What does the `open()` function do, exactly?

Q17. In a Unix-based file system, which of the following informations are stored in the file's inode? Which ones are stored elsewhere?

- Size
- Name
- Owner
- Creation time
- Last modification time
- Location of the first data block

Q18. A RAID-5 array contains 6 disks of 2 TB each. How much content can we store in it?

Q19. Show the symbol table after assembling the following program. The first statement is assigned to address 1000.

```
EVEREST:    POP BX        (1 byte)
            PUSH BP       (1 byte)
            MOV BP,SP     (2 bytes)
MCKINLEY:   PUSH X        (3 bytes)
            PUSH SI       (1 byte)
KIBO:       SUB SI,300    (3 bytes)
```

Q20. A dynamic library called `libfoo.so` contains a global variable `Foo` at address 100. Two different programs P1 and P2 use this library, however P1 linked `libfoo.so` at address 12000 while P2 linked `libfoo.so` at address 332000. Can P1 and P2 be executed simultaneously? Where is variable `Foo` located in memory?

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