THEORY OF INFORMATION, ARCHITECTURE OF COMPUTERS AND OPERATING SYSTEMS (TIACOS)
Bioinformatics, ESCI
DAC, UPC

Midterm exam **Spring 2022**

- This exam is **open book**, **closed Internet**. You can use your laptop, but do not connect to the Internet until you are told to do so.
- Write your answers in a text file named `<your_name>.<your_id>`
- Time **64 minutes**
- You will have 8 minutes at the end of the test to upload your text file to `aula.esci.upf.edu`

1. (3 points) **Short questions**
   (a) Which of the following assertions are true?
      (a) The OS facilitates the portability of the user programs
      (b) The OS aims to guarantee the robustness of the machines
      (c) The OS aims to isolate user codes from errors from others
      (d) The OS use to prepare very good coffee

      (a,b,c)

   (b) True or False? User programs do not need to use the system library to invoke system calls.

      True: but the program would not be portable

   (c) Which of the following is the correct ordering (left-to-right) of a file's compilation cycle (a filename with no extension is an executable):
      (a) `foo.c` → `foo.o` → `foo.s` → `foo`
      (b) `foo` → `foo.s` → `foo.o` → `foo.c`
      (c) `foo.c` → `foo.s` → `foo` → `foo.o`
      (d) `foo.c` → `foo.s` → `foo.o` → `foo`

      (d)

   (d) If we have 32 blocks of memory, how many bits you need to address them?

You need 5 bits to address 32 blocks.

(e) Which is called the first phase of a CPU's operation? What does it do?

It is the fetch phase, this is were we retrieve (read from memory) an instruction.

(f) Which of the following is the correct ordering (left-to-right) of a memory hierarchy from the fastest, smallest, and most expensive memory per bit.

(a) `Register → DRAM → Disk → Tape`
(b) `Register → Disk → Tape → DRAM`
(c) `DRAM → Register → TAPE → Disk`
(d) `DRAM → Register → Disk → Tape`

(a)

2. (2 points) **Filling the gaps**

Write the following 8-bits numbers as unsigned (base 10), binary (base 2), hexadecimal (base 16), and signed 2's complement (base 10) integers. Show all calculation steps.

Unsigned (base 10)	Binary (base 2)	Hexadecimal (base 16)	Signed 2's complement (base 10)
3	**00000011**	3	**3**
253	**11111101**	FD	$\mathbf{-3}$
167	**10100111**	$A7$	$\mathbf{-89}$
73	01001001	**49**	73

3. (2 points) **Floating point representation**

Suposse we are using the standard IEEE 754, 32b, normalized. Which is the real number represented by the number $0xC1D50000$? Show all calculation steps.

$$0xC1D500000 = 0b\ \overbrace{1}^{sign}\ \overbrace{10000011}^{exponent}\overbrace{10101010000000000000000}^{mantissa}$$

$$Sign: negative, e = \overbrace{131}^{exponent} - \overbrace{127}^{E_{max}} = 4, frac = \overbrace{1}^{normalized}.\overbrace{1010101}^{mantissa}$$

$$real: 1.1010101 * 2^4 = 11010.101_2 = 2^4 + 2^3 + 2^1 + 2^{-1} + 2^{-3} = \mathbf{-26.625}_{10}$$

4. (1 point) **Shell**

In a Linux system, the password file (`/etc/passwd`) has contents similar to this:

```
root:x:0:0:root:/root:/bin/bash
sync:x:4:65534:sync:/bin:/bin/sync
john:x:1000:1000:john,,,:/home/john:/bin/bash
alice:x:1001:1000:Alice,,,:/home/alice:/bin/zsh
bob:x:1002:1000:Bob:/home/bob:/bin/tcsh
```

Type a command line that searches the password file and selects the lines that match to the patterns "root" and "nobody".

```
grep -e root -e nobody /etc/passwd
```

5. (2 points) **Pyhton or C**

   Program in Python or C, a function named `bitMask(highbit, lowbit)` which generates a mask consisting of all 1's between lowbit and highbit. Examples: `bitMask(5,3)` $= 0x38 = 0b00111000$.

   * Assume $0 \leq$ `lowbit` ≤ 31, and $0 \leq$ `highbit` ≤ 31
   * If `lowbit` $>$ `highbit`, then mask should be all 0's
   * Legal ops: `!` $\sim$ `& | + << >> ^`

```
def bitMask(highbit, lowbit):
      on = (2<<highbit) + ~0
      off = (1<<lowbit) + ~0
      return on & ~off
```