Computing Infrastructure
June 15, 2022

Course Section: ☐ Prof. Ardagna ☐ Prof. Palermo ☐ Prof. Roveri

Student id (codice persona): .....

Last Name: .....
(LAST NAME IN CAPITAL LETTERS)

First Name: .....
(FIRST NAME IN CAPITAL LETTERS)

Exam Duration: 1hour and 15min

Students are not permitted to use mobile phones and similar connected devices. Course materials and programmable devices (e.g. programmable calculators) cannot be used as well. **Any violation of the rules is considered a cheating action.**

Answers must be given on the Answer Sheet. Any box filled or answer provided on the other sheets will be ignored. Students must use a pen (black or blue) to mark the answers (no pencil).

Write the LAST and FIRST name in CAPITAL LETTER, and in this order, on the first and last page of the exam. **Do not write your name on the first page of the Answer Sheet**. It is requested only the personal code.

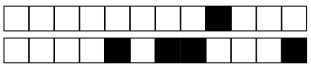
Check that the first number of the code for the Answer Sheet is the same as for the other sheets. The code can be found in the top-right corner of each page in the form `+NN/KK/XX+`. The parts that should correspond is ONLY the first digit `NN`

Do not use crosses to mark the answers, **fill clearly the box you selected** without overlapping on other boxes. If you make a mistake on them, circle the word *Question* together with the related number, and write the correct letter to its side.

Numerical exercises require to write the formulas and procedure used to solve the problem just after the question in the left space. Only the numeric answer and its unit should be reported on the corresponding dotted line in the Answer Sheet.

The answer to *Question 17* should be written using ONLY the space available on Page 2 of the Answer Sheet. The answer should be readable by the professor. Unreadable answers will be considered wrong.

Scores: correct answers take positive points, unanswered questions take 0 points, **wrong answers can have negative points**. An indication of the points is available at the beginning of each section. The final score can be re-modulated at the end of the evaluation.



Multiple choice questions

Correct answer: +2, No answer: 0, Wrong Answer -0.5

Answers must be given on the ANSWER SHEET. Any box filled here will be ignored.

Question 1

To increase reliability, which of the following actions is not correct?

- [A] Have spare components at disposal
- [B] Reduce MTTR to a minimum
- [C] Use elements with low MTTF
- [D] Use multiple redundant components

Question 2

Which of the following is not a feature of a fat tree topology in a data center network architecture?

- [A] It has a three-tier model
- [B] None of the others
- [C] It has a recursive organization
- [D] It has multiple connections to the core

Question 3

What is a Network Attached Storage (NAS)?

- [A] a computer connected to a network that provides computation to other devices
- [B] a remote storage unit connected to PC using a specific networking technology
- [C] a storage system directly attached to a server or workstation
- [D] a computer connected to a network that provides only file-based data storage services to other devices

Question 4

Select the wrong definition. A Virtual Machine:

- [A] none of the others
- [B] may appear as having different resources than the physical machine
- [C] may result in a different level of performance with respect to the physical machine
- [D] provides identical software behavior

True false questions

Correct answer: +1, No answer: 0, Wrong Answer -0.5

Answers must be given on the ANSWER SHEET. Any box filled here will be ignored. Pay attention to the position (A or B) of the True/False answers, since they are not always in the same position.

Question 5

Seek delay is the time to move the read head to the desired track

[A] True [B] False

Question 6

Tower servers can be cooled easily:

[A] True [B] False

Question 7

In the context of SSDs, Blocks are the smallest unit that can be read/written

[A] False [B] True

Question 8

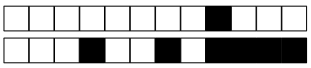
Paravirtualization cannot be used with unmodified OS

[A] True [B] False

Question 9

Paravirtualization is a particular type of kernel-level Virtualization that does not relie on a host OS

[A] False [B] True



Exercises

Correct answer: +2, No answer: 0.

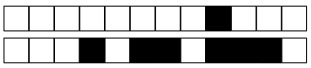
The formulas and procedures used to solve the exercises should be included here close to the question. The numeric answer, and only that, must be given on the ANSWER SHEET. Any number written only here will be ignored. The correct number is ONLY a necessary condition for a correct answer. If the formulas are not available after each exercise, they will be considered as not answered.

Question 10

Consider a server composed of 2 CPUs and a variable number of GPUs. The $MTTF_{CPU} = 500 days$ and $MTTF_{GPU} = 270 days$. Given that the server to work requires that at least 1 CPU and 1 GPU are properly working, what is the minimum number of GPUs that is needed to achieve a reliability value at $t = 120 days$ greater than 0.95? Use at least 4 decimal digits for all the intermediate calculations.

Question 11

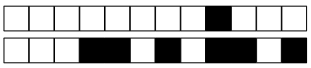
A temperature monitoring system within each rack of a Data Center is composed of two redundant sensors, a microcontroller board, and a network device. All components are repairable. We know that each component has an MTTR of 1 day, the MTTF of the sensors is $MTTF_{sen} = 8 days$ and the MTTF of the other two components is $MTTF_{micro} = MTTF_{network} = 16 days$, what is the system availability? Use at least 4 decimal digits for all the intermediate calculations.



Question 12
Consider an HDD with, 4KB as block size, 10000 RPM as rotation speed, 0.2 ms as transfer time of 1 block, 4ms as average seek time, seek time, and a negligible overhead of the controller. What is the minimum locality required to achieve an average transfer time of 1.2 sec for a file of 800KB?

Question 13
Consider a RAID 4 configuration with 10 disks. How many I/O operations are requested to update one block of a data disk (considering the sum over the entire set of disks)?

Question 14
Consider the following RAID 6 setup considering 7 disks, each one with an MTTF equal to 600 days and an MTTR equal to 5 days. What is the MTTF of the storage infrastructure?



Question 15
A system is composed of different servers. We have the possibility to fully observe only one of them, i.e. S1. It is characterized by a utilization $U_{S1} = 0.8$, an average service time of $S_{S1} = 200$ ms, and a demand of $D_{S1} = 100$ ms. What is the throughput of the server S1 (X_{S1})?

Question 16
Consider the same system and situation as in the previous question. Knowing that within the system there are on average 7 jobs (N_{Sys}), what is the average response time of the entire system (R_{Sys})?

Open Question

Correct answer: +5, No answer: 0. Points are modulated considering the written text

Write the answer using ONLY the space available on Page 2 of the Answer Sheet. The answer should be readable by the professor. Unreadable answers will be considered wrong.

Question 17

⇒ Why are HDDs still widely used in Data Centers even if SSDs provide better performance?

!!!ANY ANSWER PROVIDED IN THIS PAGE WILL BE IGNORED!!!

If needed, you can use the space hereafter to organize your answer.

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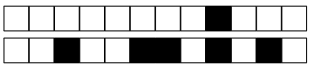
If needed, you can use this page for notes. Any answer written here will be ignored.



+8/9/42+

Computing Infrastructure - Answer Sheet (Page 1)
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Multiple Choice Questions

Question 01 : ☐A ☐B ☐C ☐D

Question 02 : ☐A ☐B ☐C ☐D

Question 03 : ☐A ☐B ☐C ☐D

Question 04 : ☐A ☐B ☐C ☐D

True/False Questions

Question 05 : ☐A ☐B

Question 06 : ☐A ☐B

Question 07 : ☐A ☐B

Question 08 : ☐A ☐B

Question 09 : ☐A ☐B

Exercises

Question 10 : .....

Question 11 : .....

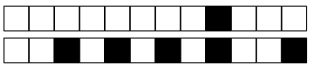
Question 12 : .....

Question 13 : .....

Question 14 : .....

Question 15 : .....

Question 16 : .....



+8/10/41+

Computing Infrastructure - Answer Sheet (Page 2)
June 15, 2022

FIRST NAME and LAST NAME in CAPITAL LETTERS

.....

(LAST NAME) (FIRST NAME)

Question 17

⇒ Why are HDDs still widely used in Data Centers even if SSDs provide better performance?

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Question	8
1	C
2	C
3	D
4	A
5	A
6	A
7	A
8	A
9	A
10	6 GPUs
11	0,8749 o 87,49%
12	0,171 o 17,14%
13	4 I/O operations
14	82285 giorni o 225 anni
15	4 Job/sec
16	7/8 sec o 0,875 sec