Computing Infrastructures
February 10, 2023

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
What is a Network Attached Storage (NAS)?

A a storage system directly attached to a server or workstation

B a computer connected to a network that provides only file-based data storage services to other devices

C a remote storage unit connected to PC using a specific networking technology

D a computer connected to a network that provides computation to other devices

Question 2
Downtime is a period of time, or a percentage of a time span, when a system is unavailable or offline _ _ _ _ _ _ _ _ _ _

A none of the other

B because of routine maintenance

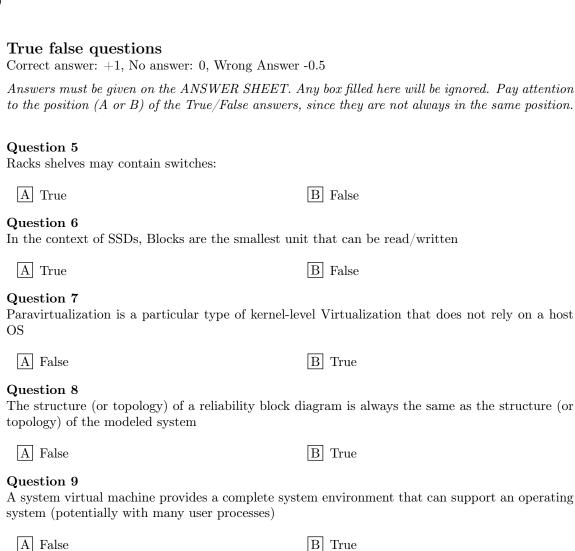C because of system crashes

D regardless of the cause

Question 3 In a three-layer network architecture of a Datacenter, which is the layer that is typically associated to the TOR switch?
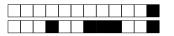
A Access

B Core

C Aggregation

D None of the others

Question 4
Which definition is not encompassed by Dependability:

A Reversibility: ability to reverse a broken service

B Reliability: continuity of correct service

C Maintainability: reparation to restore correct service

D Availability: readiness for correct service

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
Racks shelves may contain switches:

A True   B False

Question 6
In the context of SSDs, Blocks are the smallest unit that can be read/written

A True   B False

Question 7
Paravirtualization is a particular type of kernel-level Virtualization that does not rely on a host OS

A False   B True

Question 8
The structure (or topology) of a reliability block diagram is always the same as the structure (or topology) of the modeled system

A False   B True

Question 9
A system virtual machine provides a complete system environment that can support an operating system (potentially with many user processes)

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.
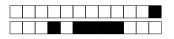
Question 10

A scientific computation uses a server composed of 2 CPUs and one TPU. Knowing that:

- The computation requires 12 days to complete.

- The computation to work requires both CPUs and the TPU within the server to be properly working.

- The $MTTF_{CPU} = 80 days$ and $MTTF_{TPU} = 40 days$.

How many instances of the computation should be executed to have a probability of 98% to have at least one instance producing the results? Notes: (i) Use at least 4 decimal digits for all the intermediate calculations; (ii) All the other components within the server can be considered as ideal.

Question 11

The PoliMi data center has two simultaneously active (redundant) cooling distribution systems. Knowing that the availability of the cooling system should be 99.99% and the MTTF of a single distribution system is 150 days, what is the maximum MTTR needed to reach the required availability value? Use at least 4 decimal digits for all the intermediate calculations.

Question 12

Consider an HDD with a data transfer rate of 20 MB/s, a rotation speed of 10000 RPM, a mean seek time of 6 ms, and a negligible overhead controller. What is the minimum locality required to achieve a mean I/O service time of 4.45 ms to transfer a sector of 2 KB?

Question 13

Consider a RAID 6 configuration with 10 disks. What is the minimum number of 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 0+1 setup considering 6 disks, each one with an MTTF equal to 600 days and an MTTR equal to 5 days. Consider a single mirror case for the RAID 1 part. What is the MTTF of the storage infrastructure?

Question 15

Your system initially includes one CPU and one disk and serves 30 users characterised by 20s think time. The CPU demanding time is $D_{CPU} = 100ms$ while the disk demanding time is $D_{DISK} = 300ms$. How many disks do you need to install in your system in a way the response time lower bound is lower than $500ms$? (hint: assume that you can evenly split the disk demand among all the disks you are going to use in your system)

Question 16

Consider the same system and situation as in the previous question. Knowing that the system response time $R_{sys} = 30s$ which is the system throughput X?

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

⇒ Describe the write-amplification problem in the context of SSDs

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

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

Computing Infrastructures - Answer Sheet (Page 1)
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Student id (codice persona): ...... *SOLUZIONE* ......

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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 : $N = 5$

Question 11 : $MTTR = 1.515$ DAYS

Question 12 : $LoC = 51.64\%$

Question 13 : 6 I/O OPS

Question 14 : 4000 DAYS

Question 15 : ALREADY OK

Question 16 : $X = 0.6 \, ^{>}/_{SEC}$