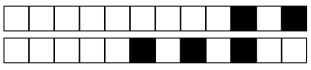


Computing Infrastructures
July 7, 2023

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 30min

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 Sheets and in English. 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, in all places where requested. **Where it is requested only the STUDENT ID (Codice Persona), do not write your name**.

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`.

Mark clearly the box corresponding to your answers, 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 writing the formulas and procedure used to solve the problem just after the question in the left space. Exercises without the procedure used to reach the result will not be considered for the evaluation. Only the numeric answer and its unit should be reported on the corresponding dotted line in the Answer Sheet.

The answers to the *Open Questions* should be written using ONLY the space available on in the boxes within the Answer Sheets. The answers should be readable by the professor. Unreadable answers will not be considered for the evaluation.

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.

True false questions

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

Answers must be given on the ANSWER SHEETS. 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 1 POD, Virtual-Chassis, DCell and BCube models are all evolutions of the leaf-spine network architectures.

A False B True

Question 2 RAID 0 provides the best read and write performance of any RAID level composed of the same amount of disks.

A True B False

Question 3 TOR switches are typically used in small-scale datacenter deployments and are not suitable for larger networks.

A True B False

Question 4 Hot/cold aisle containment reduces the efficiency of the cooling method for datacenters.

A True B False

Question 5 Edge computing is not a suitable alternative to cloud computing for applications that require large-scale data processing.

A True B False

Question 6 Virtualization can help reduce energy consumption by consolidating multiple physical machines into fewer physical ones.

A False B True

Question 7 In-row cooling systems allow for higher server densities and increased rack power densities in datacenters.

A False B True

Question 8 Datacenters within the same Geographic Areas share the same power and network infrastructure.

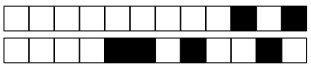
A True B False

Question 9 DAS (Direct Attached Storage) is a storage system directly attached to the datacenter network.

A True B False

Question 10 Type 2 hypervisors run on top of a guest operating system that provides indirect access to hardware resources.

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 SHEETS. 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 11

Let us consider a set of requests in the disk queue referring to the following cylinders of the disk: 57, 32, 46, 83, 12. Consider the initial position of the disk head at cylinder 54 and moving from inside (lower cylinder number) to outside (higher cylinder number). Writes the order of the served requests (from the first to the last) if the disk head scheduling algorithm adopted is C-SCAN (Circular SCAN)? Use the cylinder number to refer to the request.

Question 12

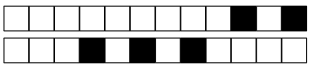
We have to design a RAID 5 storage architecture composed of an array of 6 disks. Knowing that we cannot guarantee an average MTTR lower than 6 hours and that we would like to have a MTTF for the storage infrastructure ($MTTF_{RAID5}$) higher than 15 years, what is the minimum MTTF that we should consider for each disk? Consider all the disks with the same characteristics.

Question 13
A sensing system demonstrates an average availability equal to 0.96. The system is composed of a single device that needs to be substituted when fails. Knowing that its MTTR is equal to 6 hours, what will be the reliability of a new deployed device after 5 days?

Question 14
Consider a queuing system with two stations. We have the following information about the system:

- station 1 response time: 10 s
- station 2 response time: 4 s
- station 1 throughput: 3 transactions/s
- station 2 throughput: 5 transactions/s
- system throughput: 4 transactions/s

Which is the average response time of the system?



Question 15
Your data science team develops deep learning models by relying on a server including 8 CPUs, one GPU, and one SSD disk. Your team includes $N = 10$ users who submit training jobs with a Think Time $Z = 1$ hour. Every job uses all the available CPUs. Assuming that your server demands are the following:

- $D_{CPU^i} = 2$ min $\forall i \in \{1..8\}$. I.e. Each CPU has a service demand equal to 2 min.
- $D_{GPU} = 5$ min
- $D_{Disk} = 1$ min

In the context of the asymptotic bounds, what is the system throughput upper bound and response time lower bound?

Question 16
If in the previous system (*Question 15*) you add another GPU (having hence 2 GPUs overall), what is the system throughput upper bound and response time lower bound? Consider that the original workload is evenly split across the entire set of GPUs.

Open Questions

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

Write the answer using ONLY the space available in the boxes on the ANSWER SHEETS. The answers should be readable by the professor. Unreadable answers will be considered wrong.

Question 17

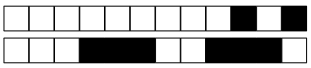
⇒ Discuss the main differences between para-virtualization and full-virtualization.

Question 18

⇒ What are the adopted strategies for efficient cooling of data center infrastructures targeting highly computational demanding applications, such as HPC and deep-learning workloads?

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

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



+5/7/14+

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Answer Sheets (Page 1)

First Name (CAPITAL LETTERS): .....

Last Name (CAPITAL LETTERS): .....

Student ID (Codice Persona): .....

Question 17

⇒ Discuss the main differences between para-virtualization and full-virtualization.

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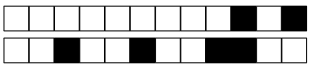
Answer Sheets (Page 2)

Question 18

⇒ What are the adopted strategies for efficient cooling of data center infrastructures targeting highly computational demanding applications, such as HPC and deep-learning workloads?



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Answer Sheets (Page 3)

Student ID (Codice Persona): .....

True/False Questions

Question 01 : [X] A [ ] B

Question 02 : [X] A [ ] B

Question 03 : [ ] A [X] B

Question 04 : [ ] A [X] B

Question 05 : [X] A [ ] B

Question 06 : [ ] A [X] B

Question 07 : [ ] A [X] B

Question 08 : [ ] A [X] B

Question 09 : [ ] A [X] B

Question 10 : [X] A [ ] B

Exercises

Question 11 : 57-83-12-32-46

Question 12 : 202,6 DAYS

Question 13 : 0.434

Question 14 : 12,5 SEC

Question 15 : $X_{MAX} = 7,31$ J/h $R_{MIN} = 22$ min

Question 16 : $X_{MAX} = 7,31$ J/h $R_{MIN} = 22$ min

DOES NOT CHANGE

+5/10/11+

Computing Infrastructures
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(FIRST NAME IN CAPITAL LETTERS)

⇒ The remaining part of this page has been intentionally left blank ⇐

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