# Computing Infrastructures July 7, 2023

Course Section:	$\Box$ Prof. Ardagna	□ Prof. Palermo	□ Prof. Roveri			
Student ID (Codice Persona):						
Last Name: (LAST NAME IN CAPITAL LETTERS)						
First Name:	(FIRST NAME I	IN CAPITAL LETTEF				

#### 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.

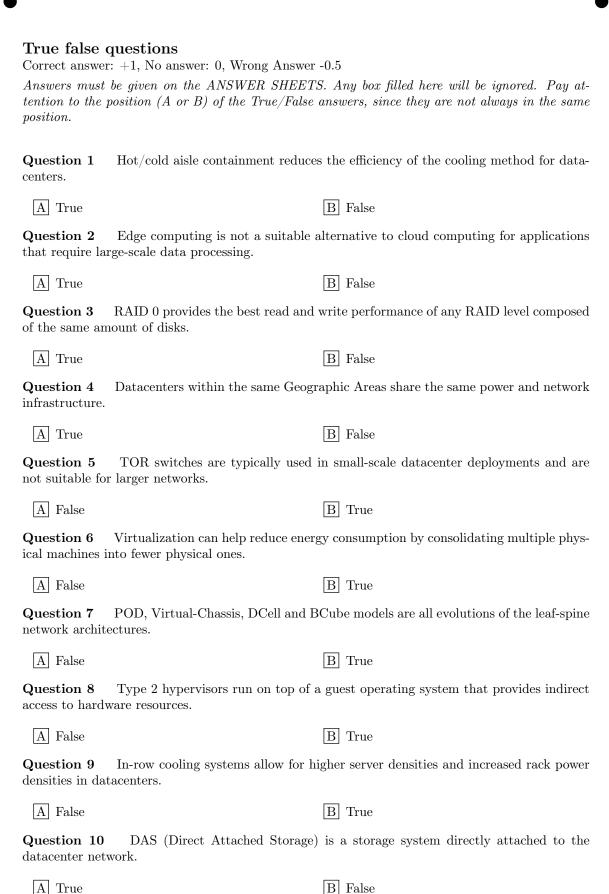
Check that the first number of the code for the Answer Sheet is the same as for the other sheets. The code can be found in the top-right corner of each page in the form +NN/KK/XX+. The parts that should correspond is ONLY the first digit NN.

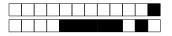
Mark clearly the box corresponding to your answers, without overlapping on other boxes. If you make a mistake on them, circle the word *Question* together with the related number, and write the correct letter to its side.

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.





### **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 8 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 0.98. The system is composed of a single device that needs to be substituted when fails. Knowing that its MTTR is equal to 3 hours, what will be the reliability of a new deployed device after 4 days?

# Question 14

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

 $\bullet\,$  station 1 response time: 5 s

• station 2 response time: 3 s

• station 1 throughput: 3 transactions/s

• station 2 throughput: 7 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.
- $D_{GPU} = 12 \text{ min}$
- $D_{Disk} = 3 \min$

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 3 more GPUs (having hence 4 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

 $\Rightarrow$  Discuss the main differences between para-virtualization and full-virtualization.

### Question 18

 $\Rightarrow$  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!!!

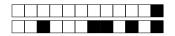
If needed, you can use the space hereafter to organize your answer.



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Answer Sheets (Page 1)

First Name (CAPITAL LETTERS):					
Last Name (CAPITAL LETTERS):					
Student ID (Codice Persona):					
Question 17					
$\Rightarrow$ Discuss the main differences between para-virtualization and full-virtualization.					



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Answer Sheets (Page 2)

Question 18
$\Rightarrow$ 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 Ques	estions
Question 01:	□A ▶B
Question 02:	<b>∑</b> A □B
Question 03 :	A B
Question 04 :	□A ▶B
Question 05:	A B
Question 06:	□A MB
Question 07:	A B
Question 08:	A B
Question 09:	□A B
Question 10:	□A B
Exercises	ra 02 12 32-16
Question 11:	57-83-12-32-46
Question 12:	276,8 DAYS
	0,52
	SSEC.
Question 15:	Xmx= 5 / Rmw = 60 min
Question 16:	Xmx=52/ Rmw=60~in Xmx=6.62/ Rnin=31~



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