Computing Infrastructures
June 15, 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**.
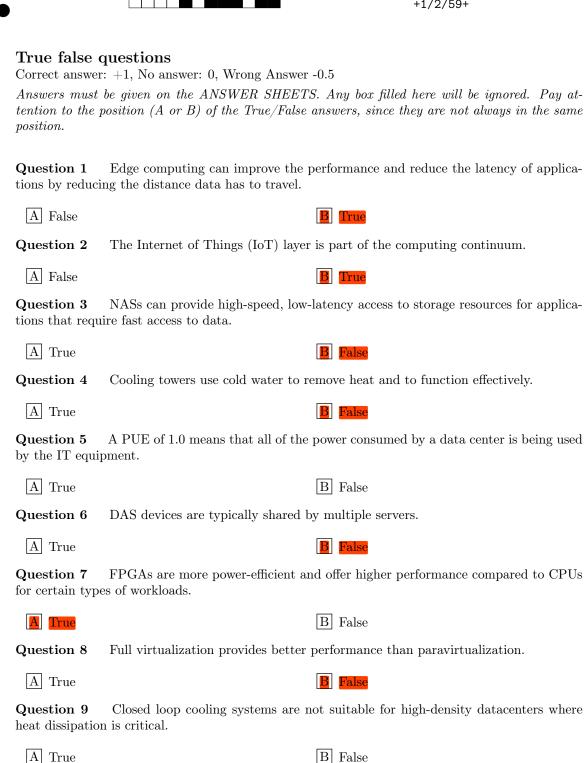
Check that the first number of the code for the Answer Sheet is the same as for the other sheets. The code can be found in the top-right corner of each page in the form +NN/KK/XX+. The parts that should correspond is ONLY the first digit NN.

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.
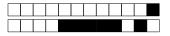
True false questions

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   Edge computing can improve the performance and reduce the latency of applications by reducing the distance data has to travel.

[A] False   [B] True

Question 2   The Internet of Things (IoT) layer is part of the computing continuum.

[A] False   [B] True

Question 3   NASs can provide high-speed, low-latency access to storage resources for applications that require fast access to data.

[A] True   [B] False

Question 4   Cooling towers use cold water to remove heat and to function effectively.

[A] True   [B] False

Question 5   A PUE of 1.0 means that all of the power consumed by a data center is being used by the IT equipment.

[A] True   [B] False

Question 6   DAS devices are typically shared by multiple servers.

[A] True   [B] False

Question 7   FPGAs are more power-efficient and offer higher performance compared to CPUs for certain types of workloads.

[A] True   [B] False

Question 8   Full virtualization provides better performance than paravirtualization.

[A] True   [B] False

Question 9   Closed loop cooling systems are not suitable for high-density datacenters where heat dissipation is critical.

[A] True   [B] False

Question 10   Cloud architectures are designed to provide on-demand access to shared computing resources.

[A] True   [B] False

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

The PoliMi data center has two simultaneously active (redundant) cooling distribution systems. Knowing that the availability of the cooling system should be 99.96% and the MTTR of a single distribution system is 15 days, what is the minimum MTTF needed to reach the required availability value? Use at least 4 decimal digits for all the intermediate calculations.

Question 12

Consider a RAID 4 configuration composed of an array with 10 disks. What is the minimum number of I/O operations requested to update one block of a single data disk (considering the sum over the entire set of disks)?

Question 13

A company wants to evaluate the performance of the services provided to its users. The computer system includes two servers Sv_1 and Sv_2. The system is initially considered as an open queue network model and the following measurements were obtained during 10-minute monitoring:

- Number of requests served at system level: $C = 300$

- Number of requests served by Sv_1: $C_{Sv1} = 600$

- Number of requests served by Sv_2: $C_{Sv2} = 100$

- Utilization $U_{Sv1} = 0.3333$

- Utilization $U_{Sv2} = 0.250$

What is the busy time B_{Sv1} and B_{Sv2}?

Question 14

Considering the system described in the previous question, what is the service demand for the two servers (D_{Sv1} and D_{Sv2})?

Question 15

Considering now the same system as a closed model with a think time $Z = 10$ sec, and the same values for the demand D_{Sv1} and D_{Sv2} calculated for the open model. In the context of the asymptotic bounds, what is the system throughput upper bound and response time lower bound for N= 40 users?

Question 16

In the same system above, if you consider two instances of Sv_1, how do the bounds change?

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
⇒ Describe the concept of fault, error, and failure in the context of a computing system.

Question 18
⇒ Discuss the main advantages of the server consolidation approach enabled by virtualization technology.

!!!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): ....

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Question 17

⇒ Describe the concept of fault, error, and failure in the context of a computing system.

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Answer Sheets (Page 2)

Question 18

⇒ Discuss the main advantages of the server consolidation approach enabled by virtualization technology.

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Answer Sheets (Page 3)

Student ID (Codice Persona): ....

True/False Questions

Question 01 : ☐A ☒B

Question 02 : ☐A ☒B

Question 03 : ☐A ☒B

Question 04 : ☐A ☒B

Question 05 : ☒A ☐B

Question 06 : ☐A ☒B

Question 07 : ☒A ☐B

Question 08 : ☐A ☒B

Question 09 : ☐A ☒B

Question 10 : ☒A ☐B

Exercises

Question 11 : 735 DAYS

Question 12 : A ⅙ OPS

Question 13 : $B_1 = 200$ SEC $B_2 = 150$ SEC

Question 14 : $D_1 = 0.666$ SEC $D_2 = 0.5$ SEC

Question 15 : $X_{MAX} = 1.5 \frac{REQ}{SEC}$ $R_{MIN} = 11.66$ SEC

Question 16 : $X_{MAX} = 2 \frac{REQ}{SEC}$ $R_{MIN} = 10$ SEC

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