Computing Infrastructures
September 5, 2024

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).

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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.

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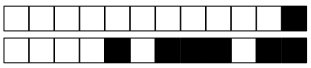


True false questions

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 Warehouse-scale computers are primarily used in small businesses with limited computing needs.

A False B True

Question 2 Given their efficiency, accelerators like GPUs and TPUs have no impact on the cooling requirements of datacenters.

A True B False

Question 3 Hypervisors can only be used to run virtual machines with the same amount of memory as the physical machine on which they are hosted.

A True B False

Question 4 Leaf-spine topologies are not suitable for highly virtualized environments with a large number of virtual machines.

A True B False

Question 5 GPUs in datacenters are primarily used for accelerating graphics rendering and video processing tasks.

A True B False

Question 6 RAID 10 provides better random write performance than RAID 6.

A True B False

Question 7 Virtualization can reduce costs by enabling the sharing of hardware resources between virtual machines.

A True B False

Question 8 RAID architectures are used to substitute regular backups

A False B True

Question 9 A UPS provides backup power to equipment during a power outage.

A True B False

Question 10 Cooling towers are not suitable for high-density datacenters.

A True B False

Exercises

Correct answer: +2, No answer: 0.

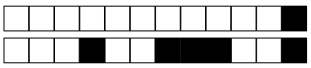
The formulas and procedures used to solve the exercises should be included here close to the question. The numeric answer, and only that, must be given on the ANSWER SHEETS. Any number written only here will be ignored. The correct number is ONLY a necessary condition for a correct answer. If the formulas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

Question 11

A monitoring system for a rack inside a data center is designed to be composed of 2 hardware sensors (M_{HW}), all necessary to extract information on the use of each blade. Each of the sensors is characterized by a MTTF of 27 days and a MTTR of 1 day. If the monitoring system were to be updated to include a purely software system (M_{SW}), from which it would be possible to extract the same usage information obtained with the HW sensors, what would be the availability of the entire blade-usage monitoring system (M_{HW} + M_{SW}) if the availability of the software system (M-SW) was 96%? Use always at least 5 decimal digits for each calculation.

Question 12

A company uses a temperature sensor to monitor a critical environment within an industrial plant. The sensor has a MTTF (Mean Time To Failure) of 4000 hours. If the company decides to replace the original sensor with a redundant version consisting of two sensors like the previous one, what is the overall reliability of the monitoring system after 2000 hours? Use always at least 4 decimal digits for each calculation.



Question 13
Consider the following RAID 1+0 setup composed of 6 disks, each one with an MTTF equal to 410 days and an MTTR equal to 2 days, and a single mirror case for the RAID 1 part. What is the MTTF of the storage infrastructure?

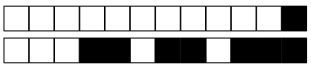
Question 14
You are tasked with performing capacity planning for an application cluster. Your system can be modeled using a closed model. On average, there are $N = 30$ users logged into the system, with a think time of $Z = 10$ seconds. Your objective is to determine whether it is more efficient to introduce:

- 10 servers, **each** with a service demand of $D_{10} = 10$ seconds, or
- A single server that is 10 times faster than each server in the previous case, with a service demand of $D_1 = 0.1$ seconds.

Calculate the lower bound on response time for both scenarios.

Question 15
Based on the system described in question 14, calculate the upper bound on throughput for both scenarios.

Question 16
Considering the system in question 14, compute the number of users N^* that determines whether the system should be analyzed using the light load or heavy load optimistic bounds.



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 characteristics, advantages, and disadvantages of Direct Attached Storage (DAS), Network Attached Storage (NAS) and Storage Area Networks (SAN).

Question 18

⇒ Descrive, comment, and contextualize the four main types of Clouds

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

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

+1/7/54+

Computing Infrastructures - September 5, 2024

Answer Sheets (Page 1)

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

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

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

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Answer Sheets (Page 2)

Question 18

⇒ Descrive, comment, and contextualize the four main types of Clouds

+1/9/52+

Computing Infrastructures - September 5, 2024

Answer Sheets (Page 3)

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

True/False Questions

Question 01 : [X] A [ ] B

Question 02 : [ ] A [X] B

Question 03 : [ ] A [X] B

Question 04 : [ ] A [X] B

Question 05 : [ ] A [X] B

Question 06 : [X] A [ ] B

Question 07 : [X] A [ ] B

Question 08 : [X] A [ ] B

Question 09 : [X] A [ ] B

Question 10 : [ ] A [X] B

Exercises

Question 11 : 0.9371

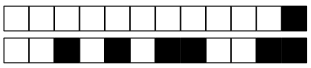
Question 12 : 0.8452

Question 13 : 14008 DAYS

Question 14 : 20 SEC | 0.1 SEC

Question 15 : 1 REQ/SEC | 237 REQ/SEC

Question 16 : N° = 20 | = 101



+1/10/51+

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True false questions

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A False B True

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A False B True

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A True B False

Question 8 RAID architectures are used to substitute regular backups

A True B False

Question 9 Leaf-spine topologies are not suitable for highly virtualized environments with a large number of virtual machines.

A True B False

Question 10 RAID 10 provides better random write performance than RAID 6.

A False B True

Exercises

Correct answer: +2, No answer: 0.

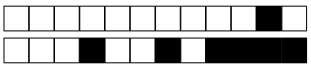
The formulas and procedures used to solve the exercises should be included here close to the question. The numeric answer, and only that, must be given on the ANSWER SHEETS. Any number written only here will be ignored. The correct number is ONLY a necessary condition for a correct answer. If the formulas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

Question 11

A monitoring system for a rack inside a data center is designed to be composed of 3 hardware sensors (M_{HW}), all necessary to extract information on the use of each blade. Each of the sensors is characterized by a MTTF of 23 days and a MTTR of 2 day. If the monitoring system were to be updated to include a purely software system (M_{SW}), from which it would be possible to extract the same usage information obtained with the HW sensors, what would be the availability of the entire blade-usage monitoring system (M_{HW} + M_{SW}) if the availability of the software system (M-SW) was 98%? Use always at least 5 decimal digits for each calculation.

Question 12

A company uses a temperature sensor to monitor a critical environment within an industrial plant. The sensor has a MTTF (Mean Time To Failure) of 4000 hours. If the company decides to replace the original sensor with a redundant version consisting of two sensors like the previous one, what is the overall reliability of the monitoring system after 2000 hours? Use always at least 4 decimal digits for each calculation.



Question 13
Consider the following RAID 1+0 setup composed of 8 disks, each one with an MTTF equal to 410 days and an MTTR equal to 2 days, and a single mirror case for the RAID 1 part. What is the MTTF of the storage infrastructure?

Question 14
You are tasked with performing capacity planning for an application cluster. Your system can be modeled using a closed model. On average, there are $N = 30$ users logged into the system, with a think time of $Z = 10$ seconds. Your objective is to determine whether it is more efficient to introduce:

- 10 servers, **each** with a service demand of $D_{10} = 10$ seconds, or
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Calculate the lower bound on response time for both scenarios.

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Based on the system described in question 14, calculate the upper bound on throughput for both scenarios.

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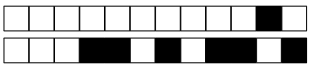

Open Questions

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Question 17

⇒ Describe characteristics, advantages, and disadvantages of Direct Attached Storage (DAS), Network Attached Storage (NAS) and Storage Area Networks (SAN).

Question 18

⇒ Descrive, comment, and contextualize the four main types of Clouds

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+2/7/44+

Computing Infrastructures - September 5, 2024

Answer Sheets (Page 1)

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Computing Infrastructures - September 5, 2024

Answer Sheets (Page 2)

Question 18

⇒ Descrive, comment, and contextualize the four main types of Clouds

+2/9/42+

Computing Infrastructures - September 5, 2024

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 : 0.93557

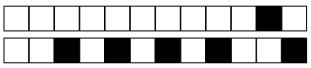
Question 12 : 0.8452

Question 13 : 10506 DAYS

Question 14 : 20 SEC | 0.1 SEC

Question 15 : 1 REQ/S | 2.37 REQ/SEC

Question 16 : N° = 20 | = 101



+2/10/41+

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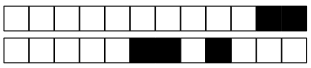

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Exercises

Correct answer: +2, No answer: 0.

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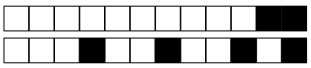

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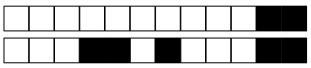

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+3/7/34+

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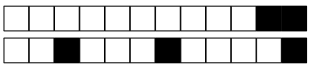

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Computing Infrastructures - September 5, 2024

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 : 0.9874 3

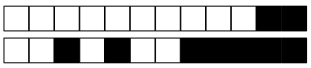
Question 12 : 0,8452

Question 13 : 5603 Days

Question 14 : 52,5 | 0.255C

Question 15 : 0.5 R=Ω/s | 2,34 R=Ω/sec

Question 16 : N° = 15 | = 51



+3/10/31+

Computing Infrastructures
September 5, 2024

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)

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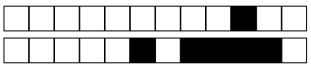
If needed, you can use this page for notes. Any answer written here will be ignored.



Computing Infrastructures
September 5, 2024

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

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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 Virtualization can reduce costs by enabling the sharing of hardware resources between virtual machines.

A True B False

Question 2 Warehouse-scale computers are primarily used in small businesses with limited computing needs.

A True B False

Question 3 RAID architectures are used to substitute regular backups

A False B True

Question 4 GPUs in datacenters are primarily used for accelerating graphics rendering and video processing tasks.

A False B True

Question 5 Cooling towers are not suitable for high-density datacenters.

A False B True

Question 6 RAID 10 provides better random write performance than RAID 6.

A False B True

Question 7 Leaf-spine topologies are not suitable for highly virtualized environments with a large number of virtual machines.

A True B False

Question 8 Given their efficiency, accelerators like GPUs and TPUs have no impact on the cooling requirements of datacenters.

A True B False

Question 9 A UPS provides backup power to equipment during a power outage.

A True B False

Question 10 Hypervisors can only be used to run virtual machines with the same amount of memory as the physical machine on which they are hosted.

A True B False

Exercises

Correct answer: +2, No answer: 0.

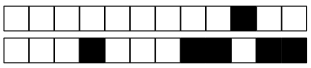
The formulas and procedures used to solve the exercises should be included here close to the question. The numeric answer, and only that, must be given on the ANSWER SHEETS. Any number written only here will be ignored. The correct number is ONLY a necessary condition for a correct answer. If the formulas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

Question 11

A monitoring system for a rack inside a data center is designed to be composed of 2 hardware sensors (M_{HW}), all necessary to extract information on the use of each blade. Each of the sensors is characterized by a MTTF of 27 days and a MTTR of 1 day. If the monitoring system were to be updated to include a purely software system (M_{SW}), from which it would be possible to extract the same usage information obtained with the HW sensors, what would be the availability of the entire blade-usage monitoring system (M_{HW} + M_{SW}) if the availability of the software system (M-SW) was 96%? Use always at least 5 decimal digits for each calculation.

Question 12

A company uses a temperature sensor to monitor a critical environment within an industrial plant. The sensor has a MTTF (Mean Time To Failure) of 4000 hours. If the company decides to replace the original sensor with a redundant version consisting of two sensors like the previous one, what is the overall reliability of the monitoring system after 2000 hours? Use always at least 4 decimal digits for each calculation.



Question 13
Consider the following RAID 1+0 setup composed of 6 disks, each one with an MTTF equal to 410 days and an MTTR equal to 5 days, and a single mirror case for the RAID 1 part. What is the MTTF of the storage infrastructure?

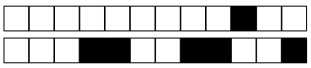
Question 14
You are tasked with performing capacity planning for an application cluster. Your system can be modeled using a closed model. On average, there are $N = 30$ users logged into the system, with a think time of $Z = 10$ seconds. Your objective is to determine whether it is more efficient to introduce:

- 10 servers, **each** with a service demand of $D_{10} = 3$ seconds, or
- A single server that is 10 times faster than each server in the previous case, with a service demand of $D_1 = 0.3$ seconds.

Calculate the lower bound on response time for both scenarios.

Question 15
Based on the system described in question 14, calculate the upper bound on throughput for both scenarios.

Question 16
Considering the system in question 14, compute the number of users N^* that determines whether the system should be analyzed using the light load or heavy load optimistic bounds.



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

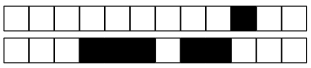
⇒ Describe characteristics, advantages, and disadvantages of Direct Attached Storage (DAS), Network Attached Storage (NAS) and Storage Area Networks (SAN).

Question 18

⇒ Descrive, comment, and contextualize the four main types of Clouds

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

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



+4/7/24+

Computing Infrastructures - September 5, 2024

Answer Sheets (Page 1)

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

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

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

Question 17

⇒ Describe characteristics, advantages, and disadvantages of Direct Attached Storage (DAS), Network Attached Storage (NAS) and Storage Area Networks (SAN).

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Computing Infrastructures - September 5, 2024

Answer Sheets (Page 2)

Question 18

⇒ Descrive, comment, and contextualize the four main types of Clouds

+4/9/22+

Computing Infrastructures - September 5, 2024

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 : 0.993719

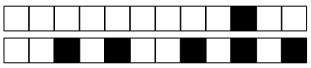
Question 12 : 0.8452

Question 13 : 5603 Days

Question 14 : 80sec | 0.3 sec

Question 15 : 0.333 Req/s | 2.5 Req/s

Question 16 : $N^* = 13.333$ | $= 36,333$



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Computing Infrastructures
September 5, 2024

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

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

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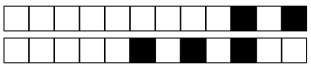

Computing Infrastructures
September 5, 2024

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

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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 Virtualization can reduce costs by enabling the sharing of hardware resources between virtual machines.

A False B True

Question 2 RAID 10 provides better random write performance than RAID 6.

A False B True

Question 3 Hypervisors can only be used to run virtual machines with the same amount of memory as the physical machine on which they are hosted.

A False B True

Question 4 Warehouse-scale computers are primarily used in small businesses with limited computing needs.

A False B True

Question 5 Cooling towers are not suitable for high-density datacenters.

A True B False

Question 6 RAID architectures are used to substitute regular backups

A True B False

Question 7 GPUs in datacenters are primarily used for accelerating graphics rendering and video processing tasks.

A True B False

Question 8 Leaf-spine topologies are not suitable for highly virtualized environments with a large number of virtual machines.

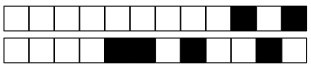
A True B False

Question 9 A UPS provides backup power to equipment during a power outage.

A False B True

Question 10 Given their efficiency, accelerators like GPUs and TPUs have no impact on the cooling requirements of datacenters.

A False B True



Exercises

Correct answer: +2, No answer: 0.

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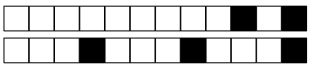
Question 11

A monitoring system for a rack inside a data center is designed to be composed of 3 hardware sensors (M_{HW}), all necessary to extract information on the use of each blade. Each of the sensors is characterized by a MTTF of 23 days and a MTTR of 2 day. If the monitoring system were to be updated to include a purely software system (M_{SW}), from which it would be possible to extract the same usage information obtained with the HW sensors, what would be the availability of the entire blade-usage monitoring system (M_{HW} + M_{SW}) if the availability of the software system (M-SW) was 98%? Use always at least 5 decimal digits for each calculation.

Question 12

A company uses a temperature sensor to monitor a critical environment within an industrial plant. The sensor has a MTTF (Mean Time To Failure) of 5000 hours. If the company decides to replace the original sensor with a redundant version consisting of two sensors like the previous one, what is the overall reliability of the monitoring system after 2000 hours? Use always at least 4 decimal digits for each calculation.



Question 13
Consider the following RAID 1+0 setup composed of 6 disks, each one with an MTTF equal to 410 days and an MTTR equal to 5 days, and a single mirror case for the RAID 1 part. What is the MTTF of the storage infrastructure?

Question 14
You are tasked with performing capacity planning for an application cluster. Your system can be modeled using a closed model. On average, there are $N = 30$ users logged into the system, with a think time of $Z = 10$ seconds. Your objective is to determine whether it is more efficient to introduce:

- 10 servers, **each** with a service demand of $D_{10} = 3$ seconds, or
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Calculate the lower bound on response time for both scenarios.

Question 15
Based on the system described in question 14, calculate the upper bound on throughput for both scenarios.

Question 16
Considering the system in question 14, compute the number of users N^* that determines whether the system should be analyzed using the light load or heavy load optimistic bounds.

Open Questions

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Question 17

⇒ Describe characteristics, advantages, and disadvantages of Direct Attached Storage (DAS), Network Attached Storage (NAS) and Storage Area Networks (SAN).

Question 18

⇒ Descrive, comment, and contextualize the four main types of Clouds

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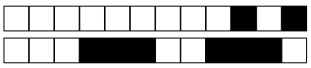

+5/7/14+

Computing Infrastructures - September 5, 2024

Answer Sheets (Page 1)

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

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

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

Question 17

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Computing Infrastructures - September 5, 2024

Answer Sheets (Page 2)

Question 18

⇒ Descrive, comment, and contextualize the four main types of Clouds

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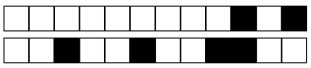


+5/9/12+

Computing Infrastructures - September 5, 2024

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 : 0.99557

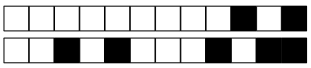
Question 12 : 0.8813

Question 13 : 5603 Days

Question 14 : 80 | 0.3

Question 15 : 0.33 Req/s | 2.91 Req/sec

Question 16 : N° = 13,337 | 34,333



+5/10/11+

Computing Infrastructures
September 5, 2024

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

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

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

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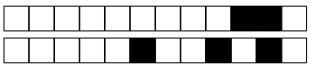

Computing Infrastructures
September 5, 2024

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

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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 Warehouse-scale computers are primarily used in small businesses with limited computing needs.

A False B True

Question 2 GPUs in datacenters are primarily used for accelerating graphics rendering and video processing tasks.

A True B False

Question 3 Given their efficiency, accelerators like GPUs and TPUs have no impact on the cooling requirements of datacenters.

A True B False

Question 4 Leaf-spine topologies are not suitable for highly virtualized environments with a large number of virtual machines.

A False B True

Question 5 RAID architectures are used to substitute regular backups

A True B False

Question 6 Cooling towers are not suitable for high-density datacenters.

A False B True

Question 7 Virtualization can reduce costs by enabling the sharing of hardware resources between virtual machines.

A True B False

Question 8 RAID 10 provides better random write performance than RAID 6.

A True B False

Question 9 A UPS provides backup power to equipment during a power outage.

A False B True

Question 10 Hypervisors can only be used to run virtual machines with the same amount of memory as the physical machine on which they are hosted.

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

A monitoring system for a rack inside a data center is designed to be composed of 3 hardware sensors (M_{HW}), all necessary to extract information on the use of each blade. Each of the sensors is characterized by a MTTF of 27 days and a MTTR of 1 day. If the monitoring system were to be updated to include a purely software system (M_{SW}), from which it would be possible to extract the same usage information obtained with the HW sensors, what would be the availability of the entire blade-usage monitoring system (M_{HW} + M_{SW}) if the availability of the software system (M-SW) was 98%? Use always at least 5 decimal digits for each calculation.

Question 12

A company uses a temperature sensor to monitor a critical environment within an industrial plant. The sensor has a MTTF (Mean Time To Failure) of 4000 hours. If the company decides to replace the original sensor with a redundant version consisting of two sensors like the previous one, what is the overall reliability of the monitoring system after 3000 hours? Use always at least 4 decimal digits for each calculation.

Question 13
Consider the following RAID 1+0 setup composed of 6 disks, each one with an MTTF equal to 410 days and an MTTR equal to 2 days, and a single mirror case for the RAID 1 part. What is the MTTF of the storage infrastructure?

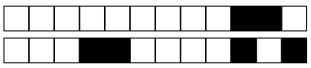
Question 14
You are tasked with performing capacity planning for an application cluster. Your system can be modeled using a closed model. On average, there are $N = 30$ users logged into the system, with a think time of $Z = 10$ seconds. Your objective is to determine whether it is more efficient to introduce:

- 10 servers, **each** with a service demand of $D_{10} = 3$ seconds, or
- A single server that is 10 times faster than each server in the previous case, with a service demand of $D_1 = 0.3$ seconds.

Calculate the lower bound on response time for both scenarios.

Question 15
Based on the system described in question 14, calculate the upper bound on throughput for both scenarios.

Question 16
Considering the system in question 14, compute the number of users N^* that determines whether the system should be analyzed using the light load or heavy load optimistic bounds.



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

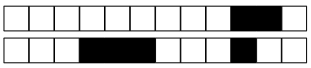
⇒ Describe characteristics, advantages, and disadvantages of Direct Attached Storage (DAS), Network Attached Storage (NAS) and Storage Area Networks (SAN).

Question 18

⇒ Descrive, comment, and contextualize the four main types of Clouds

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

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



+6/7/4+

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Answer Sheets (Page 1)

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

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

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

Question 17

⇒ Describe characteristics, advantages, and disadvantages of Direct Attached Storage (DAS), Network Attached Storage (NAS) and Storage Area Networks (SAN).

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Answer Sheets (Page 2)

Question 18

⇒ Descrive, comment, and contextualize the four main types of Clouds

+6/9/2+

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Answer Sheets (Page 3)

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

True/False Questions

Question 01 : [X] A [ ] B

Question 02 : [ ] A [X] B

Question 03 : [ ] A [X] B

Question 04 : [X] A [ ] B

Question 05 : [ ] A [X] B

Question 06 : [X] A [ ] B

Question 07 : [X] A [ ] B

Question 08 : [X] A [ ] B

Question 09 : [X] A [ ] B

Question 10 : [ ] A [X] B

Exercises

Question 11 : 0.99793

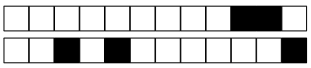
Question 12 : 0.7216

Question 13 : 14008 DAYS

Question 14 : 80 | 0.3

Question 15 : 0.333 R30/S | 2.91 R60/S

Question 16 : N=13,333 | -34,333



+6/10/1+

Computing Infrastructures
September 5, 2024

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)

⇒ 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.