+1/1/60+

# Computing Infrastructures
# July 10, 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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**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 help reduce the amount of data that needs to be transferred to the cloud or central data center.

A True B False

**Question 2** Open loop (free) cooling systems are less suitable for large-scale high-density datacenters where heat dissipation is a significant challenge.

A False B True

**Question 3** Containers provide virtualization at the operating system level.

A True B False

**Question 4** NASs are primarily used for block-level access to data, while SAN devices provide file-level access.

A False B True

**Question 5** A hot aisle/cold aisle configuration is the most common method for organizing server racks in a datacenter.

A False B True

**Question 6** RAID 0 can tolerate the failure of one disk.

A False B True

**Question 7** Type 1 hypervisors run directly on the host machine's hardware and have direct access to hardware resources.

A False B True

**Question 8** Datacenter networks are not designed with oversubscription

A True B False

**Question 9** Closed loop cooling systems are generally more expensive to install and maintain compared to open loop (free cooling) systems.

A False B True

**Question 10** GPUs require specialized software and programming frameworks to fully leverage their parallel processing capabilities.

A False B True



## Exercises

Correct answer: +2, No answer: 0.

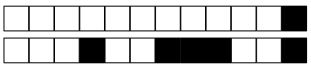
*The formulas and procedures used to solve the exercises should be included here close to the question. The numeric answer, and only that, must be given on the ANSWER SHEETS. Any number written only here will be ignored. The correct number is ONLY a necessary condition for a correct answer. If the formulas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

**Question 11**

Consider an HDD with the following characteristics: block size 4KB, average seek time 3ms, data transfer time for a single block 0.5ms, and a negligible overhead controller. Knowing that the average locality is 75% and the average I/O service time to transfer an 800KB file is 400ms, what is the rotation speed for the disk in RPM?

**Question 12**

Consider a RAID 5 configuration composed of an array with 8 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**
During the procurement of a server for an important scientific calculation, 3 different solutions have been offered.

- Server A allows to complete the target calculation in 400 hours, it has a MTTF of 1600 hours, and a MTTR of 3 hours;
- Server B allows to complete the target calculation in 500 hours, it has a MTTF of 1750 hours, and a MTTR of 4 hours.
- Server C allows to complete the target calculation in 600 hours, and it has a MTTR of 5 hours.

We know that the decision on which solution to buy depends on which server has the higher probability of completing the calculation before failure, once the calculation it is started. What should be the minimum MTTF for Server C to be selected as the system to buy? Use at least 4 decimal digit for each intermediate calculation.

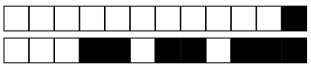
**Question 14**
Using a two-tier leaf-spine topology without oversubscription and adopting only switches with 8 ports (all switches have the same number of ports), what is the maximum number of servers that can be connected?

**Question 15**
A company wants to evaluate the performance of the services provided to its users. The computer system includes two servers $S1$ and $S2$. The system is considered as an open queue network model where the two servers work in tandem and the following measurements were obtained during 20-minute monitoring:

- Number of requests served at the system level: $C = 400$
- Number of requests served by server $S1$: $C_{S1} = 800$
- Number of requests served by server $S2$: $C_{S2} = 200$
- Busy time for server $S1$: $B_{S1} = 300$ sec
- Busy time for server $S2$: $B_{S2} = 900$ sec

What are the service demand and utilization for server $S1$ and server $S2$ ($D_{S1}$, $D_{S2}$, $U_{S1}$, $U_{S2}$)?
$D_{S1} = ?$ $D_{S2} = ?$ $U_{S1} = ?$ $U_{S2} = ?$

**Question 16**
Considering the same system as in the previous question 15, if you predict that your incoming workload is going to reach $\lambda = 3$ req/sec, what is the minimum number of instances for each type of server $N_{S1}$ and $N_{S1}$ that you need to introduce to keep their utilization less or equal to 60%? (Note1: when you introduce additional server instances at each layer of the tandem queue, you can assume that they equally split the number of visits across the server of the same type. Note 2: The service time of each server does not change while adding servers or increasing its workload.).
$N_{S1} = ?$ $N_{S2} = ?$





## 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**

⇒ *"SSD disks will replace HDDs in all the datacenters"*. Provide your opinion about this sentence and comment with details and examples.

**Question 18**

⇒ Rank and comment the most energy consuming aspects (both IT and not) in datacenters.

**!!!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 - July 10, 2024

**Answer Sheets (Page 1)**

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

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

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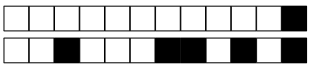



# Computing Infrastructures - July 10, 2024

**Answer Sheets (Page 2)**

**Question 18**

⇒ Rank and comment the most energy consuming aspects (both IT and not) in datacenters.

+1/9/52+

# Computing Infrastructures - July 10, 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

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Question 10 : ☐A ☐B

## Exercises

Question 11 : Disk Rotation Speed [RPM] = .....

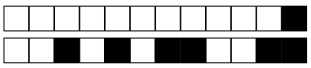
Question 12 : Number of I/O operations = .....

Question 13 : Minimum $MTTF_{ServerC}$ [hours] = .....

Question 14 : Maximum number of servers = .....

Question 15 : $D_{S1}$ = ..... $D_{S2}$ = ..... $U_{S1}$ = ..... $U_{S2}$ = .....

Question 16 : $N_{S1}$ = ..... $N_{S2}$ = .....



+1/10/51+

# Computing Infrastructures
## July 10, 2024

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## July 10, 2024

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## True false questions

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

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**Question 1** Closed loop cooling systems are generally more expensive to install and maintain compared to open loop (free cooling) systems.

A False B True

**Question 2** A hot aisle/cold aisle configuration is the most common method for organizing server racks in a datacenter.

A False B True

**Question 3** Type 1 hypervisors run directly on the host machine's hardware and have direct access to hardware resources.

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**Question 4** NASs are primarily used for block-level access to data, while SAN devices provide file-level access.

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**Question 5** Containers provide virtualization at the operating system level.

A True B False

**Question 6** GPUs require specialized software and programming frameworks to fully leverage their parallel processing capabilities.

A True B False

**Question 7** RAID 0 can tolerate the failure of one disk.

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**Question 8** Open loop (free) cooling systems are less suitable for large-scale high-density datacenters where heat dissipation is a significant challenge.

A True B False

**Question 9** Edge computing can help reduce the amount of data that needs to be transferred to the cloud or central data center.

A True B False

**Question 10** Datacenter networks are not designed with oversubscription

A True B False



## Exercises

Correct answer: +2, No answer: 0.

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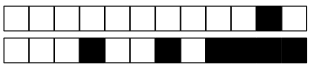
**Question 11**

Consider an HDD with the following characteristics: block size 4KB, average seek time 3ms, data transfer time for a single block 0.5ms, and a negligible overhead controller. Knowing that the average locality is 60% and the average I/O service time to transfer an 800KB file is 740ms, what is the rotation speed for the disk in RPM?

**Question 12**

Consider a RAID 4 configuration composed of an array with 8 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)?





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During the procurement of a server for an important scientific calculation, 3 different solutions have been offered.

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**Question 14**
Using a two-tier leaf-spine topology without oversubscription and adopting only switches with 6 ports (all switches have the same number of ports), what is the maximum number of servers that can be connected?

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- Number of requests served by $S_1$: $C_{S1} = 800$
- Number of requests served by $S_2$: $C_{S2} = 200$
- Busy time $S_1$: $B_{S1} = 600$ sec
- Busy time $S_2$: $B_{S2} = 850$ sec

What are the service demand and utilization for server $S1$ and server $S2$ ($D_{S1}$, $D_{S2}$, $U_{S1}$, $U_{S2}$)?
$D_{S1} = ?$ $D_{S2} = ?$ $U_{S1} = ?$ $U_{S2} = ?$

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Considering the same system as in the previous question 15, if you predict that your incoming workload is going to reach $\lambda = 3$ req/sec, what is the minimum number of instances for each type of server $N_{S1}$ and $N_{S1}$ that you need to introduce to keep their utilization less or equal to 60%? (Note1: when you introduce additional server instances at each layer of the tandem queue, you can assume that they equally split the number of visits across the server of the same type. Note 2: The service time of each server does not change while adding servers or increasing its workload.).
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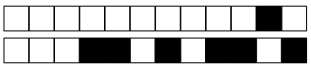



## Open Questions

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**Question 17**

⇒ *"SSD disks will replace HDDs in all the datacenters"*. Provide your opinion about this sentence and comment with details and examples.

**Question 18**

⇒ Rank and comment the most energy consuming aspects (both IT and not) in datacenters.

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+2/7/44+

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**Answer Sheets (Page 1)**

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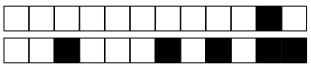



# Computing Infrastructures - July 10, 2024

**Answer Sheets (Page 2)**

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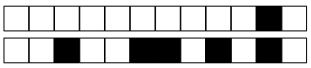

+2/9/42+

# Computing Infrastructures - July 10, 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

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## Exercises

Question 11 : Disk Rotation Speed [RPM] = .....

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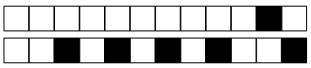

+2/10/41+

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

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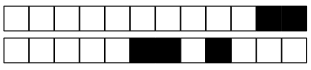



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## Exercises

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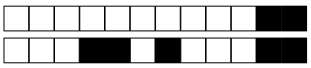
- Busy time $S_1$: $B_{S1} = 600$ sec
- Busy time $S_2$: $B_{S2} = 850$ sec

What are the service demand and utilization for server $S1$ and server $S2$ ($D_{S1}$, $D_{S2}$, $U_{S1}$, $U_{S2}$)?
$D_{S1} = ?$ $D_{S2} = ?$ $U_{S1} = ?$ $U_{S2} = ?$

**Question 16**
Considering the same system as in the previous question 15, if you predict that your incoming workload is going to reach $\lambda = 3$ req/sec, what is the minimum number of instances for each type of server $N_{S1}$ and $N_{S1}$ that you need to introduce to keep their utilization less or equal to 60%? (Note1: when you introduce additional server instances at each layer of the tandem queue, you can assume that they equally split the number of visits across the server of the same type. Note 2: The service time of each server does not change while adding servers or increasing its workload.).
$N_{S1} = ?$ $N_{S2} = ?$





## 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**

⇒ *"SSD disks will replace HDDs in all the datacenters"*. Provide your opinion about this sentence and comment with details and examples.

**Question 18**

⇒ Rank and comment the most energy consuming aspects (both IT and not) in datacenters.

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

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

+3/7/34+

# Computing Infrastructures - July 10, 2024

**Answer Sheets (Page 1)**

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

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

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

**Question 17**

$\Rightarrow$ *"SSD disks will replace HDDs in all the datacenters"*. Provide your opinion about this sentence and comment with details and examples.

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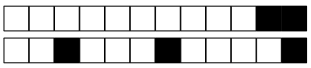



# Computing Infrastructures - July 10, 2024

**Answer Sheets (Page 2)**

**Question 18**

⇒ Rank and comment the most energy consuming aspects (both IT and not) in datacenters.

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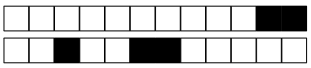

+3/9/32+

# Computing Infrastructures - July 10, 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

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Question 10 : ☐A ☐B

## Exercises

Question 11 : Disk Rotation Speed [RPM] = .....

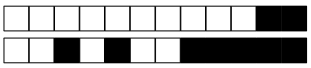
Question 12 : Number of I/O operations = .....

Question 13 : Minimum $MTTF_{ServerC}$ [hours] = .....

Question 14 : Maximum number of servers = .....

Question 15 : $D_{S1}$ = ..... $D_{S2}$ = ..... $U_{S1}$ = ..... $U_{S2}$ = .....

Question 16 : $N_{S1}$ = ..... $N_{S2}$ = .....



+3/10/31+

# Computing Infrastructures
## July 10, 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** ⇐

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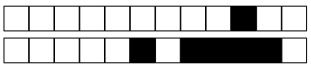



# Computing Infrastructures
# July 10, 2024

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

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

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

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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** Open loop (free) cooling systems are less suitable for large-scale high-density datacenters where heat dissipation is a significant challenge.

A False B True

**Question 2** Type 1 hypervisors run directly on the host machine's hardware and have direct access to hardware resources.

A False B True

**Question 3** Containers provide virtualization at the operating system level.

A False B True

**Question 4** Edge computing can help reduce the amount of data that needs to be transferred to the cloud or central data center.

A False B True

**Question 5** NASs are primarily used for block-level access to data, while SAN devices provide file-level access.

A True B False

**Question 6** RAID 0 can tolerate the failure of one disk.

A True B False

**Question 7** Datacenter networks are not designed with oversubscription

A False B True

**Question 8** Closed loop cooling systems are generally more expensive to install and maintain compared to open loop (free cooling) systems.

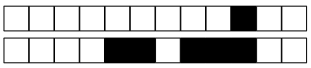
A False B True

**Question 9** A hot aisle/cold aisle configuration is the most common method for organizing server racks in a datacenter.

A False B True

**Question 10** GPUs require specialized software and programming frameworks to fully leverage their parallel processing capabilities.

A True B False





## Exercises

Correct answer: +2, No answer: 0.

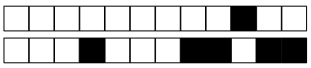
*The formulas and procedures used to solve the exercises should be included here close to the question. The numeric answer, and only that, must be given on the ANSWER SHEETS. Any number written only here will be ignored. The correct number is ONLY a necessary condition for a correct answer. If the formulas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

**Question 11**

Consider an HDD with the following characteristics: block size 4KB, average seek time 3ms, data transfer time for a single block 0.5ms, and a negligible overhead controller. Knowing that the average locality is 60% and the average I/O service time to transfer an 800KB file is 740ms, what is the rotation speed for the disk in RPM?

**Question 12**

Consider a RAID 4 configuration composed of an array with 8 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)?



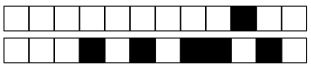


**Question 13**
During the procurement of a server for an important scientific calculation, 3 different solutions have been offered.

- Server A allows to complete the target calculation in 400 hours, it has a MTTF of 1200 hours, and a MTTR of 3 hours;
- Server B allows to complete the target calculation in 500 hours, it has a MTTF of 1300 hours, and a MTTR of 4 hours.
- Server C allows to complete the target calculation in 600 hours, and it has a MTTR of 5 hours.

We know that the decision on which solution to buy depends on which server has the higher probability of completing the calculation before failure, once the calculation it is started. What should be the minimum MTTF for Server C to be selected as the system to buy? Use at least 4 decimal digit for each intermediate calculation.

**Question 14**
Using a two-tier leaf-spine topology without oversubscription and adopting only switches with 8 ports (all switches have the same number of ports), what is the maximum number of servers that can be connected?



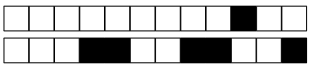


**Question 15**
A company wants to evaluate the performance of the services provided to its users. The computer system includes two servers $S_1$ and $S_2$. The system is considered as an open queue network model where the two servers work in tandem and the following measurements were obtained during 20-minute monitoring:

- Number of requests served at the system level: $C = 800$
- Number of requests served by $S_1$: $C_{S1} = 800$
- Number of requests served by $S_2$: $C_{S2} = 200$
- Busy time $S_1$: $B_{S1} = 300$ sec
- Busy time $S_2$: $B_{S2} = 450$ sec

What are the service demand and utilization for server $S1$ and server $S2$ ($D_{S1}$, $D_{S2}$, $U_{S1}$, $U_{S2}$)?
$D_{S1} = ?$ $D_{S2} = ?$ $U_{S1} = ?$ $U_{S2} = ?$

**Question 16**
Considering the same system as in the previous question 15, if you predict that your incoming workload is going to reach $\lambda = 3$ req/sec, what is the minimum number of instances for each type of server $N_{S1}$ and $N_{S1}$ that you need to introduce to keep their utilization less or equal to 70%? (Note1: when you introduce additional server instances at each layer of the tandem queue, you can assume that they equally split the number of visits across the server of the same type. Note 2: The service time of each server does not change while adding servers or increasing its workload.).
$N_{S1} = ?$ $N_{S2} = ?$





## 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**

⇒ *"SSD disks will replace HDDs in all the datacenters"*. Provide your opinion about this sentence and comment with details and examples.

**Question 18**

⇒ Rank and comment the most energy consuming aspects (both IT and not) in datacenters.

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

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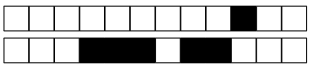

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# Computing Infrastructures - July 10, 2024

**Answer Sheets (Page 1)**

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

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

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

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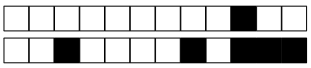


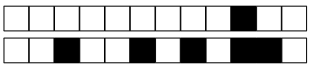


# Computing Infrastructures - July 10, 2024

**Answer Sheets (Page 2)**

**Question 18**

⇒ Rank and comment the most energy consuming aspects (both IT and not) in datacenters.



+4/9/22+

# Computing Infrastructures - July 10, 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

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## Exercises

Question 11 : Disk Rotation Speed [RPM] = .....

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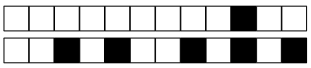

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# Computing Infrastructures
# July 10, 2024

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

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

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

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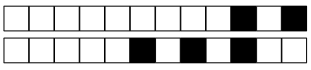



# Computing Infrastructures
# July 10, 2024

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## True false questions

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

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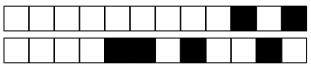



## Exercises

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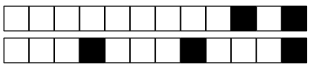
**Question 11**

Consider an HDD with the following characteristics: block size 4KB, average seek time 3ms, data transfer time for a single block 0.5ms, and a negligible overhead controller. Knowing that the average locality is 75% and the average I/O service time to transfer an 800KB file is 400ms, what is the rotation speed for the disk in RPM?

**Question 12**

Consider a RAID 5 configuration composed of an array with 8 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**
During the procurement of a server for an important scientific calculation, 3 different solutions have been offered.

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**Question 14**
Using a two-tier leaf-spine topology without oversubscription and adopting only switches with 6 ports (all switches have the same number of ports), what is the maximum number of servers that can be connected?

**Question 15**
A company wants to evaluate the performance of the services provided to its users. The computer system includes two servers $S_1$ and $S_2$. The system is considered as an open queue network model where the two servers work in tandem and the following measurements were obtained during 20-minute monitoring:

- Number of requests served at the system level: $C = 400$
- Number of requests served by $S_1$: $C_{S1} = 800$
- Number of requests served by $S_2$: $C_{S2} = 200$
- Busy time $S_1$: $B_{S1} = 600$ sec
- Busy time $S_2$: $B_{S2} = 850$ sec

What are the service demand and utilization for server $S1$ and server $S2$ ($D_{S1}$, $D_{S2}$, $U_{S1}$, $U_{S2}$)?
$D_{S1} = ?$ $D_{S2} = ?$ $U_{S1} = ?$ $U_{S2} = ?$

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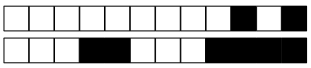




## Open Questions

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**

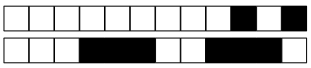
⇒ *"SSD disks will replace HDDs in all the datacenters"*. Provide your opinion about this sentence and comment with details and examples.

**Question 18**

⇒ Rank and comment the most energy consuming aspects (both IT and not) in datacenters.

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

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



+5/7/14+

# Computing Infrastructures - July 10, 2024

**Answer Sheets (Page 1)**

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

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

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

**Question 17**

$\Rightarrow$ *"SSD disks will replace HDDs in all the datacenters"*. Provide your opinion about this sentence and comment with details and examples.

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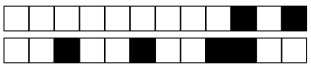
# Computing Infrastructures - July 10, 2024

**Answer Sheets (Page 2)**

**Question 18**

⇒ Rank and comment the most energy consuming aspects (both IT and not) in datacenters.



+5/9/12+

# Computing Infrastructures - July 10, 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 : Disk Rotation Speed [RPM] = .....

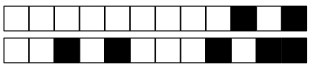
Question 12 : Number of I/O operations = .....

Question 13 : Minimum $MTTF_{ServerC}$ [hours] = .....

Question 14 : Maximum number of servers = .....

Question 15 : $D_{S1}$ = ..... $D_{S2}$ = ..... $U_{S1}$ = ..... $U_{S2}$ = .....

Question 16 : $N_{S1}$ = ..... $N_{S2}$ = .....



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# Computing Infrastructures
## July 10, 2024

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

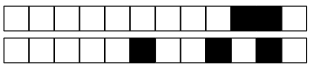
Student ID (Codice Persona): .....

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.





# Computing Infrastructures
# July 10, 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).

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**.

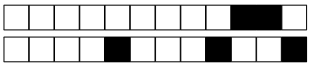
**Check that the first number of the code for the Answer Sheet** is the same as for the other sheets. The code can be found in the top-right corner of each page in the form `+NN/KK/XX+`. The parts that should correspond is ONLY the first digit `NN`.

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** Closed loop cooling systems are generally more expensive to install and maintain compared to open loop (free cooling) systems.

A True B False

**Question 2** RAID 0 can tolerate the failure of one disk.

A False B True

**Question 3** Containers provide virtualization at the operating system level.

A True B False

**Question 4** NASs are primarily used for block-level access to data, while SAN devices provide file-level access.

A False B True

**Question 5** Edge computing can help reduce the amount of data that needs to be transferred to the cloud or central data center.

A True B False

**Question 6** A hot aisle/cold aisle configuration is the most common method for organizing server racks in a datacenter.

A False B True

**Question 7** GPUs require specialized software and programming frameworks to fully leverage their parallel processing capabilities.

A True B False

**Question 8** Open loop (free) cooling systems are less suitable for large-scale high-density datacenters where heat dissipation is a significant challenge.

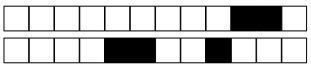
A False B True

**Question 9** Datacenter networks are not designed with oversubscription

A True B False

**Question 10** Type 1 hypervisors run directly on the host machine's hardware and have direct access to hardware 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**

Consider an HDD with the following characteristics: block size 4KB, average seek time 3ms, data transfer time for a single block 0.5ms, and a negligible overhead controller. Knowing that the average locality is 75% and the average I/O service time to transfer an 800KB file is 400ms, what is the rotation speed for the disk in RPM?

**Question 12**

Consider a RAID 5 configuration composed of an array with 8 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**
During the procurement of a server for an important scientific calculation, 3 different solutions have been offered.

- Server A allows to complete the target calculation in 400 hours, it has a MTTF of 1600 hours, and a MTTR of 3 hours;
- Server B allows to complete the target calculation in 500 hours, it has a MTTF of 1750 hours, and a MTTR of 4 hours.
- Server C allows to complete the target calculation in 600 hours, and it has a MTTR of 5 hours.

We know that the decision on which solution to buy depends on which server has the higher probability of completing the calculation before failure, once the calculation it is started. What should be the minimum MTTF for Server C to be selected as the system to buy? Use at least 4 decimal digit for each intermediate calculation.

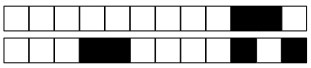
**Question 14**
Using a two-tier leaf-spine topology without oversubscription and adopting only switches with 8 ports (all switches have the same number of ports), what is the maximum number of servers that can be connected?

**Question 15**
A company wants to evaluate the performance of the services provided to its users. The computer system includes two servers $S_1$ and $S_2$. The system is considered as an open queue network model where the two servers work in tandem and the following measurements were obtained during 20-minute monitoring:

- Number of requests served at the system level: $C = 800$
- Number of requests served by $S_1$: $C_{S1} = 800$
- Number of requests served by $S_2$: $C_{S2} = 200$
- Busy time $S_1$: $B_{S1} = 300$ sec
- Busy time $S_2$: $B_{S2} = 450$ sec

What are the service demand and utilization for server $S1$ and server $S2$ ($D_{S1}$, $D_{S2}$, $U_{S1}$, $U_{S2}$)?
$D_{S1} = ?$ $D_{S2} = ?$ $U_{S1} = ?$ $U_{S2} = ?$

**Question 16**
Considering the same system as in the previous question 15, if you predict that your incoming workload is going to reach $\lambda = 3$ req/sec, what is the minimum number of instances for each type of server $N_{S1}$ and $N_{S1}$ that you need to introduce to keep their utilization less or equal to 70%? (Note1: when you introduce additional server instances at each layer of the tandem queue, you can assume that they equally split the number of visits across the server of the same type. Note 2: The service time of each server does not change while adding servers or increasing its workload.).
$N_{S1} = ?$ $N_{S2} = ?$





## 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**

⇒ *"SSD disks will replace HDDs in all the datacenters"*. Provide your opinion about this sentence and comment with details and examples.

**Question 18**

⇒ Rank and comment the most energy consuming aspects (both IT and not) in datacenters.

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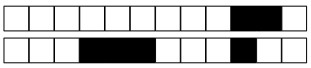

+6/7/4+

# Computing Infrastructures - July 10, 2024

**Answer Sheets (Page 1)**

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# Computing Infrastructures - July 10, 2024

**Answer Sheets (Page 2)**

**Question 18**

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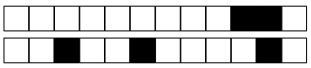

+6/9/2+

# Computing Infrastructures - July 10, 2024

**Answer Sheets (Page 3)**

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

## True/False Questions

Question 01 : ☐A ☐B

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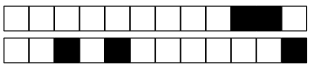

+6/10/1+

# Computing Infrastructures
## July 10, 2024

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

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