Computing Infrastructures
February 3, 2025

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   Data centers requires specialized fire suppression systems.

A False   **B True**

Question 2   In current datacenters, east-west traffic is typically less bandwidth-intensive than north-south traffic.

A False   B True

Question 3   Cloud computing does not require the user to manage the underlying hardware infrastructure, instead relying on the cloud provider to manage it.

A True   B False

Question 4   RAID 6 offers better random read performance than RAID 5.

A True   B False

Question 5   Cloud architectures can help reduce the cost of IT infrastructure by enabling pay-as-you-go pricing.

A True   B False

Question 6   In-rack cooling involves placing cooling units directly in the server racks.

A False   B True

Question 7   RAID 5 has a higher storage overhead than RAID 4.

A True   B False

Question 8   Oversubscription is not used in TOR switches

A False   B True

Question 9   A three-tier network architecture is never used in leaf-spine architectures

A False   B True

Question 10   Raised floor systems in data centers help with cable management and airflow distribution.

A False   B True

Exercises

Correct answer: +2, No answer: 0.

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

Question 11

Let us consider a set of requests in the disk queue referring to the following cylinders of the disk: 65, 23, 50, 8, 39. Consider the initial position of the disk head at cylinder 52 and it is moving from inside (lower cylinder number) to outside (higher cylinder number). If no further requests arrive, write the order of the served requests (from the first to the last) if the disk head scheduling algorithm adopted is SCAN? Use the cylinder number to refer to the request.

Question 12

A company uses a computing system composed of three servers: one front-end server and two back-end servers. The system remains operational even if one of the two back-end servers fails. In all other cases, the system is considered offline. All servers have a Mean Time To Failure (MTTF) of 8 months. (i) Compute the probability that at least one of the three servers fails within the first 40 days, and (ii) compute the overall reliability of the computing system after 40 days. *Notes: Use at least 4 decimal places for each intermediate calculation.*

Question 13

A company uses a distributed data storage system composed of five storage units, organized in a *primary* and *secondary* storage groups, according to the following scheme: (i) Two redundant *primary* storage units (S_1 and S_2), meaning that the system continues to work as long as at least one of the two remains operational; (ii) Three *secondary* storage units (S_3, S_4, and S_5) in a configuration that requires that all three secondary units must be operational; (iii) Both storage groups should be operational to have the data storage system working. Each storage unit has the following parameters: Mean Time To Failure (MTTF) = 8 months; Mean Time To Repair (MTTR) = 5 day. Compute the overall availability of the system. *Notes: Use at least 5 decimal places for each intermediate calculation.*

Question 14

You have been assigned the responsibility of optimizing the web server of your company. Through the analysis of your system logs, you have collected the following data (assume that this data is gathered during the peak hour, i.e., T= 1h, on a representative business day).

Number of completed requests C= 10000
Average system utilization U=0.5

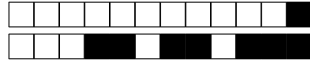What is the system throughput X and the requests service demand D?

Question 15

Considering the system described in Question 14, what is the maximum throughput that the system can achieve?

Question 16

Given the system described in Question 14, assume an expected peak workload growth of 4x (i.e. four times more requests within the same time interval). Determine the minimum number of additional servers required to ensure that the system utilization does not exceed 60%. Assume that all new servers have the same configuration as the existing ones and that the incoming requests are evenly distributed across all servers. The answer should include the *total number of servers* required, including the original one.

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

⇒ Explain the concept of Wear Leveling in the context of SSD.

Question 18

⇒ Discuss the concept of Datacenter Availability, and define what are the differences among the Tier Levels established by the Uptime Institute.

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

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

Computing Infrastructures - February 3, 2025

Answer Sheets (Page 3)

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

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 : $65 - 50 - 38 - 23 - 8$

Question 12 : $0.3935 - 0.8265$

Question 13 : 0.93962

Question 14 : $X = 2.7 \frac{REQ}{S}$ $D = 180 mS$

Question 15 : $X_{MAX} = 5.5 \frac{REQ}{SEC}$

Question 16 : $N = 4$

Computing Infrastructures
February 3, 2025

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   In current datacenters, east-west traffic is typically less bandwidth-intensive than north-south traffic.

A False   B True

Question 2   RAID 5 has a higher storage overhead than RAID 4.

A False   B True

Question 3   Cloud computing does not require the user to manage the underlying hardware infrastructure, instead relying on the cloud provider to manage it.

A True   B False

Question 4   RAID 6 offers better random read performance than RAID 5.

A True   B False

Question 5   Oversubscription is not used in TOR switches

A True   B False

Question 6   Data centers requires specialized fire suppression systems.

A False   B True

Question 7   A three-tier network architecture is never used in leaf-spine architectures

A False   B True

Question 8   Raised floor systems in data centers help with cable management and airflow distribution.

A True   B False

Question 9   Cloud architectures can help reduce the cost of IT infrastructure by enabling pay-as-you-go pricing.

A True   B False

Question 10   In-rack cooling involves placing cooling units directly in the server racks.

A False   B True

Exercises

Correct answer: +2, No answer: 0.

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

Question 11

Let us consider a set of requests in the disk queue referring to the following cylinders of the disk: 65, 23, 50, 8, 39. Consider the initial position of the disk head at cylinder 52 and it is moving from inside (lower cylinder number) to outside (higher cylinder number). If no further requests arrive, write the order of the served requests (from the first to the last) if the disk head scheduling algorithm adopted is SCAN? Use the cylinder number to refer to the request.

Question 12

A company uses a computing system composed of three servers: one front-end server and two back-end servers. The system remains operational even if one of the two back-end servers fails. In all other cases, the system is considered offline. All servers have a Mean Time To Failure (MTTF) of 9 months. (i) Compute the probability that at least one of the three servers fails within the first 40 days, and (ii) compute the overall reliability of the computing system after 40 days. *Notes: Use at least 4 decimal places for each intermediate calculation.*

Question 13

A company uses a distributed data storage system composed of five storage units, organized in a *primary* and *secondary* storage groups, according to the following scheme: (i) Two redundant *primary* storage units (S_1 and S_2), meaning that the system continues to work as long as at least one of the two remains operational; (ii) Three *secondary* storage units (S_3, S_4, and S_5) in a configuration that requires that all three secondary units must be operational; (iii) Both storage groups should be operational to have the data storage system working. Each storage unit has the following parameters: Mean Time To Failure (MTTF) = 8 months; Mean Time To Repair (MTTR) = 5 day. Compute the overall availability of the system. *Notes: Use at least 5 decimal places for each intermediate calculation.*

Question 14

You have been assigned the responsibility of optimizing the web server of your company. Through the analysis of your system logs, you have collected the following data (assume that this data is gathered during the peak hour, i.e., $T=$ 1h, on a representative business day).

Number of completed requests $C=$ 10000
Average system utilization $U=0.5$

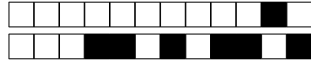What is the system throughput X and the requests service demand D?

Question 15

Considering the system described in Question 14, what is the maximum throughput that the system can achieve?

Question 16

Given the system described in Question 14, assume an expected peak workload growth of 4x (i.e. four times more requests within the same time interval). Determine the minimum number of additional servers required to ensure that the system utilization does not exceed 60%. Assume that all new servers have the same configuration as the existing ones and that the incoming requests are evenly distributed across all servers. The answer should include the *total number of servers* required, including the original one.

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

⇒ Explain the concept of Wear Leveling in the context of SSD.

Question 18

⇒ Discuss the concept of Datacenter Availability, and define what are the differences among the Tier Levels established by the Uptime Institute.

!!!ANY ANSWER PROVIDED ON THIS PAGE WILL BE IGNORED!!!
If needed, you can use the space hereafter to organize your answer.

Computing Infrastructures - February 3, 2025

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 : $65-50-33-23-8$

Question 12 : $0.3588 - 0.8960$

Question 13 : 0.93962

Question 14 : $X = 2.7 \frac{REQ}{SEC}$ $D = 130 ms$

Question 15 : $X_{MAX} = 5,5 \frac{REQ}{SEC}$

Question 16 : $N = 4$

Computing Infrastructures
February 3, 2025

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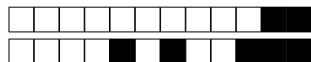
Check that the first number of the code for the Answer Sheet is the same as for the other sheets. The code can be found in the top-right corner of each page in the form +NN/KK/XX+. The parts that should correspond is ONLY the first digit NN.

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   Cloud computing does not require the user to manage the underlying hardware infrastructure, instead relying on the cloud provider to manage it.

A True   B False

Question 2   In-rack cooling involves placing cooling units directly in the server racks.

A True   B False

Question 3   A three-tier network architecture is never used in leaf-spine architectures

A False   B True

Question 4   In current datacenters, east-west traffic is typically less bandwidth-intensive than north-south traffic.

A False   B True

Question 5   RAID 6 offers better random read performance than RAID 5.

A False   B True

Question 6   RAID 5 has a higher storage overhead than RAID 4.

A False   B True

Question 7   Cloud architectures can help reduce the cost of IT infrastructure by enabling pay-as-you-go pricing.

A True   B False

Question 8   Data centers requires specialized fire suppression systems.

A False   B True

Question 9   Raised floor systems in data centers help with cable management and airflow distribution.

A True   B False

Question 10   Oversubscription is not used in TOR switches

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

Let us consider a set of requests in the disk queue referring to the following cylinders of the disk: 65, 23, 50, 8, 39. Consider the initial position of the disk head at cylinder 53 and it is moving from outside (higher cylinder number) to inside (lower cylinder number). If no further requests arrive, write the order of the served requests (from the first to the last) if the disk head scheduling algorithm adopted is SCAN? Use the cylinder number to refer to the request.

Question 12

A company uses a computing system composed of three servers: one front-end server and two back-end servers. The system remains operational even if one of the two back-end servers fails. In all other cases, the system is considered offline. All servers have a Mean Time To Failure (MTTF) of 9 months. (i) Compute the probability that at least one of the three servers fails within the first 40 days, and (ii) compute the overall reliability of the computing system after 40 days. *Notes: Use at least 4 decimal places for each intermediate calculation.*

Question 13

A company uses a distributed data storage system composed of five storage units, organized in a *primary* and *secondary* storage groups, according to the following scheme: (i) Two redundant *primary* storage units (S_1 and S_2), meaning that the system continues to work as long as at least one of the two remains operational; (ii) Three *secondary* storage units (S_3, S_4, and S_5) in a configuration that requires that all three secondary units must be operational; (iii) Both storage groups should be operational to have the data storage system working. Each storage unit has the following parameters: Mean Time To Failure (MTTF) = 8 months; Mean Time To Repair (MTTR) = 5 day. Compute the overall availability of the system. *Notes: Use at least 5 decimal places for each intermediate calculation.*

Question 14

You have been assigned the responsibility of optimizing the web server of your company. Through the analysis of your system logs, you have collected the following data (assume that this data is gathered during the peak hour, i.e., $T=$ 1h, on a representative business day).

Number of completed requests $C=$ 10000
Average system utilization $U=0.5$

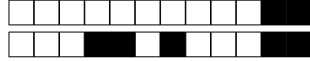What is the system throughput X and the requests service demand D?

Question 15
Considering the system described in Question 14, what is the maximum throughput that the system can achieve?

Question 16
Given the system described in Question 14, assume an expected peak workload growth of 4x (i.e. four times more requests within the same time interval). Determine the minimum number of additional servers required to ensure that the system utilization does not exceed 60%. Assume that all new servers have the same configuration as the existing ones and that the incoming requests are evenly distributed across all servers. The answer should include the *total number of servers* required, including the original one.

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

⇒ Explain the concept of Wear Leveling in the context of SSD.

Question 18

⇒ Discuss the concept of Datacenter Availability, and define what are the differences among the Tier Levels established by the Uptime Institute.

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

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

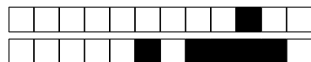# Computing Infrastructures - February 3, 2025

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 : 50 - 38 - 23 - 8 - 65

Question 12 : 0,3588 — 0.8460

Question 13 : 0,83962

Question 14 : $X = 2.7 \frac{Req}{sec}$ $D = 180 \, msec$

Question 15 : $X_{MAX} = 5,5 \frac{Req}{sec}$

Question 16 : $N = 4$

Computing Infrastructures
February 3, 2025

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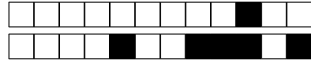
Check that the first number of the code for the Answer Sheet is the same as for the other sheets. The code can be found in the top-right corner of each page in the form +NN/KK/XX+. The parts that should correspond is ONLY the first digit NN.

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   Data centers requires specialized fire suppression systems.

A True   B False

Question 2   RAID 6 offers better random read performance than RAID 5.

A True   B False

Question 3   A three-tier network architecture is never used in leaf-spine architectures

A True   B False

Question 4   In-rack cooling involves placing cooling units directly in the server racks.

A False   B True

Question 5   Oversubscription is not used in TOR switches

A True   B False

Question 6   Cloud computing does not require the user to manage the underlying hardware infrastructure, instead relying on the cloud provider to manage it.

A True   B False

Question 7   Cloud architectures can help reduce the cost of IT infrastructure by enabling pay-as-you-go pricing.

A False   B True

Question 8   RAID 5 has a higher storage overhead than RAID 4.

A False   B True

Question 9   In current datacenters, east-west traffic is typically less bandwidth-intensive than north-south traffic.

A True   B False

Question 10   Raised floor systems in data centers help with cable management and airflow distribution.

A False   B True

Exercises

Correct answer: $+2$, No answer: 0.

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

Question 11

Let us consider a set of requests in the disk queue referring to the following cylinders of the disk: 65, 23, 50, 8, 39. Consider the initial position of the disk head at cylinder 52 and it is moving from inside (lower cylinder number) to outside (higher cylinder number). If no further requests arrive, write the order of the served requests (from the first to the last) if the disk head scheduling algorithm adopted is SCAN? Use the cylinder number to refer to the request.

Question 12

A company uses a computing system composed of three servers: one front-end server and two back-end servers. The system remains operational even if one of the two back-end servers fails. In all other cases, the system is considered offline. All servers have a Mean Time To Failure (MTTF) of 8 months. (i) Compute the probability that at least one of the three servers fails within the first 40 days, and (ii) compute the overall reliability of the computing system after 40 days. *Notes: Use at least 4 decimal places for each intermediate calculation.*

Question 13

A company uses a distributed data storage system composed of five storage units, organized in a *primary* and *secondary* storage groups, according to the following scheme: (i) Two redundant *primary* storage units (S_1 and S_2), meaning that the system continues to work as long as at least one of the two remains operational; (ii) Three *secondary* storage units (S_3, S_4, and S_5) in a configuration that requires that all three secondary units must be operational; (iii) Both storage groups should be operational to have the data storage system working. Each storage unit has the following parameters: Mean Time To Failure (MTTF) = 9 months; Mean Time To Repair (MTTR) = 8 day. Compute the overall availability of the system. *Notes: Use at least 5 decimal places for each intermediate calculation.*
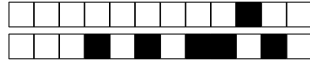
Question 14

You have been assigned the responsibility of optimizing the web server of your company. Through the analysis of your system logs, you have collected the following data (assume that this data is gathered during the peak hour, i.e., T= 1h, on a representative business day).

Number of completed requests C= 10000
Average system utilization U=0.5

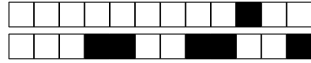What is the system throughput X and the requests service demand D?

Question 15

Considering the system described in Question 14, what is the maximum throughput that the system can achieve?

Question 16

Given the system described in Question 14, assume an expected peak workload growth of 4x (i.e. four times more requests within the same time interval). Determine the minimum number of additional servers required to ensure that the system utilization does not exceed 60%. Assume that all new servers have the same configuration as the existing ones and that the incoming requests are evenly distributed across all servers. The answer should include the *total number of servers required*, including the original one.

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

⇒ Explain the concept of Wear Leveling in the context of SSD.

Question 18

⇒ Discuss the concept of Datacenter Availability, and define what are the differences among the Tier Levels established by the Uptime Institute.

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

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

Computing Infrastructures - February 3, 2025

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 : 65-50-38-23-8

Question 12 : 0,3835 − 0.8265

Question 13 : 0.91537

Question 14 : $X = 2.7 \frac{Req}{sec}$ $D = 180 \, ms$

Question 15 : $X_{MAX} = 5.5 \frac{Req}{sec}$

Question 16 : $N = 4$

Computing Infrastructures
February 3, 2025

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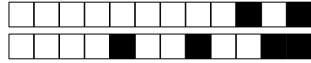
Check that the first number of the code for the Answer Sheet is the same as for the other sheets. The code can be found in the top-right corner of each page in the form `+NN/KK/XX+`. The parts that should correspond is ONLY the first digit `NN`.

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   RAID 5 has a higher storage overhead than RAID 4.

[A] False   [B] True

Question 2   RAID 6 offers better random read performance than RAID 5.

[A] True   [B] False

Question 3   In-rack cooling involves placing cooling units directly in the server racks.

[A] True   [B] False

Question 4   Oversubscription is not used in TOR switches

[A] True   [B] False

Question 5   Cloud architectures can help reduce the cost of IT infrastructure by enabling pay-as-you-go pricing.

[A] False   [B] True

Question 6   Data centers requires specialized fire suppression systems.

[A] True   [B] False

Question 7   Cloud computing does not require the user to manage the underlying hardware infrastructure, instead relying on the cloud provider to manage it.

[A] True   [B] False

Question 8   A three-tier network architecture is never used in leaf-spine architectures

[A] False   [B] True

Question 9   In current datacenters, east-west traffic is typically less bandwidth-intensive than north-south traffic.

[A] True   [B] False

Question 10   Raised floor systems in data centers help with cable management and airflow distribution.

[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

Let us consider a set of requests in the disk queue referring to the following cylinders of the disk: 65, 23, 50, 8, 39. Consider the initial position of the disk head at cylinder 52 and it is moving from inside (lower cylinder number) to outside (higher cylinder number). If no further requests arrive, write the order of the served requests (from the first to the last) if the disk head scheduling algorithm adopted is SCAN? Use the cylinder number to refer to the request.

Question 12

A company uses a computing system composed of three servers: one front-end server and two back-end servers. The system remains operational even if one of the two back-end servers fails. In all other cases, the system is considered offline. All servers have a Mean Time To Failure (MTTF) of 8 months. (i) Compute the probability that at least one of the three servers fails within the first 40 days, and (ii) compute the overall reliability of the computing system after 40 days. *Notes: Use at least 4 decimal places for each intermediate calculation.*

Question 13

A company uses a distributed data storage system composed of five storage units, organized in a *primary* and *secondary* storage groups, according to the following scheme: (i) Two redundant *primary* storage units (S_1 and S_2), meaning that the system continues to work as long as at least one of the two remains operational; (ii) Three *secondary* storage units (S_3, S_4, and S_5) in a configuration that requires that all three secondary units must be operational; (iii) Both storage groups should be operational to have the data storage system working. Each storage unit has the following parameters: Mean Time To Failure (MTTF) = 8 months; Mean Time To Repair (MTTR) = 5 day. Compute the overall availability of the system. *Notes: Use at least 5 decimal places for each intermediate calculation.*

Question 14

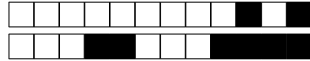You have been assigned the responsibility of optimizing the web server of your company. Through the analysis of your system logs, you have collected the following data (assume that this data is gathered during the peak hour, i.e., $T=$ 1h, on a representative business day).

Number of completed requests $C=$ 10000
Average system utilization $U=0.5$

What is the system throughput X and the requests service demand D?

Question 15

Considering the system described in Question 14, what is the maximum throughput that the system can achieve?

Question 16

Given the system described in Question 14, assume an expected peak workload growth of 4x (i.e. four times more requests within the same time interval). Determine the minimum number of additional servers required to ensure that the system utilization does not exceed 60%. Assume that all new servers have the same configuration as the existing ones and that the incoming requests are evenly distributed across all servers. The answer should include the *total number of servers required*, including the original one.

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
⇒ Explain the concept of Wear Leveling in the context of SSD.

Question 18
⇒ Discuss the concept of Datacenter Availability, and define what are the differences among the Tier Levels established by the Uptime Institute.

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

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

Computing Infrastructures - February 3, 2025

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 : $65-50-39-23-8$

Question 12 : $0,3334 \quad - 0,8265$

Question 13 : 0.93962

Question 14 : $x = 2.7 \frac{Req}{Sec} \qquad D = 180ms$

Question 15 : $x_{MAX} = 5.5 \frac{Req}{Sec}$

Question 16 : $N = 6$

Computing Infrastructures
February 3, 2025

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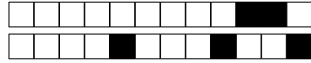
Check that the first number of the code for the Answer Sheet is the same as for the other sheets. The code can be found in the top-right corner of each page in the form +NN/KK/XX+. The parts that should correspond is ONLY the first digit NN.

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   A three-tier network architecture is never used in leaf-spine architectures

A False   B True

Question 2   In current datacenters, east-west traffic is typically less bandwidth-intensive than north-south traffic.

A False   B True

Question 3   RAID 6 offers better random read performance than RAID 5.

A True   B False

Question 4   Cloud architectures can help reduce the cost of IT infrastructure by enabling pay-as-you-go pricing.

A True   B False

Question 5   In-rack cooling involves placing cooling units directly in the server racks.

A True   B False

Question 6   RAID 5 has a higher storage overhead than RAID 4.

A False   B True

Question 7   Cloud computing does not require the user to manage the underlying hardware infrastructure, instead relying on the cloud provider to manage it.

A False   B True

Question 8   Oversubscription is not used in TOR switches

A True   B False

Question 9   Data centers requires specialized fire suppression systems.

A False   B True

Question 10   Raised floor systems in data centers help with cable management and airflow distribution.

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

Let us consider a set of requests in the disk queue referring to the following cylinders of the disk: 65, 23, 50, 8, 39. Consider the initial position of the disk head at cylinder 52 and it is moving from inside (lower cylinder number) to outside (higher cylinder number). If no further requests arrive, write the order of the served requests (from the first to the last) if the disk head scheduling algorithm adopted is SCAN? Use the cylinder number to refer to the request.

Question 12

A company uses a computing system composed of three servers: one front-end server and two back-end servers. The system remains operational even if one of the two back-end servers fails. In all other cases, the system is considered offline. All servers have a Mean Time To Failure (MTTF) of 9 months. (i) Compute the probability that at least one of the three servers fails within the first 40 days, and (ii) compute the overall reliability of the computing system after 40 days. *Notes: Use at least 4 decimal places for each intermediate calculation.*

Question 13

A company uses a distributed data storage system composed of five storage units, organized in a *primary* and *secondary* storage groups, according to the following scheme: (i) Two redundant *primary* storage units (S_1 and S_2), meaning that the system continues to work as long as at least one of the two remains operational; (ii) Three *secondary* storage units (S_3, S_4, and S_5) in a configuration that requires that all three secondary units must be operational; (iii) Both storage groups should be operational to have the data storage system working. Each storage unit has the following parameters: Mean Time To Failure (MTTF) = 9 months; Mean Time To Repair (MTTR) = 8 day. Compute the overall availability of the system. *Notes: Use at least 5 decimal places for each intermediate calculation.*
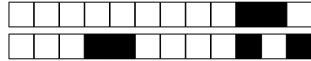
Question 14

You have been assigned the responsibility of optimizing the web server of your company. Through the analysis of your system logs, you have collected the following data (assume that this data is gathered during the peak hour, i.e., T= 1h, on a representative business day).

Number of completed requests C= 20000
Average system utilization U=0.5

What is the system throughput X and the requests service demand D?

Question 15

Considering the system described in Question 14, what is the maximum throughput that the system can achieve?

Question 16

Given the system described in Question 14, assume an expected peak workload growth of 4x (i.e. four times more requests within the same time interval). Determine the minimum number of additional servers required to ensure that the system utilization does not exceed 70%. Assume that all new servers have the same configuration as the existing ones and that the incoming requests are evenly distributed across all servers. The answer should include the *total number of servers* required, including the original one.

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

⇒ Explain the concept of Wear Leveling in the context of SSD.

Question 18

⇒ Discuss the concept of Datacenter Availability, and define what are the differences among the Tier Levels established by the Uptime Institute.

!!!ANY ANSWER PROVIDED ON THIS PAGE WILL BE IGNORED!!!
If needed, you can use the space hereafter to organize your answer.

Computing Infrastructures - February 3, 2025

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 : $65-50-38-23-8$

Question 12 : $0.3588 - 0.8460$

Question 13 : $0.8153 \bar{t}$

Question 14 : $X = 5.55 \, Req/sec \quad D = 80 \, ms$

Question 15 : $X MAX = 11.1 \, Req/sec$

Question 16 : $N = 3$