Computing Infrastructures
June 12, 2024

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

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

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

First Name: .....
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Exam Duration: 1hour and 30min

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Numerical exercises require writing the formulas and procedure used to solve the problem just after the question in the left space. Exercises without the procedure used to reach the result will not be considered for the evaluation. Only the numeric answer and its unit should be reported on the corresponding dotted line in the Answer Sheet.

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True false questions

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

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Question 1 Virtualization can reduce costs by enabling the sharing of hardware resources between virtual machines.

[A] False [B] True

Question 2 In-row cooling systems allow for higher server densities and increased rack power densities in datacenters.

[A] True [B] False

Question 3 RAID 6 offers better random and sequential write performance than RAID 5.

[A] False [B] True

Question 4 The computing continuum refers to the idea that computing devices exist on a spectrum, from small, low-power devices to large, high-performance machines.

[A] False [B] True

Question 5 In-row cooling involves placing cooling units between server racks.

[A] True [B] False

Question 6 Full virtualization can run on a wider range of hardware than paravirtualization.

[A] True [B] False

Question 7 In current datacenters east-west traffic typically involves lower data volumes compared to north-south traffic.

[A] True [B] False

Question 8 TPUs are more power-efficient and offer higher performance compared to GPUs in deep learning tasks.

[A] False [B] True

Question 9 DAS devices connect directly to a network and are accessed over the network by clients.

[A] False [B] True

Question 10 Controlling humidity levels in a datacenter is important for preventing equipment failures.

[A] True [B] False

Exercises

Correct answer: +2, No answer: 0.

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Question 11

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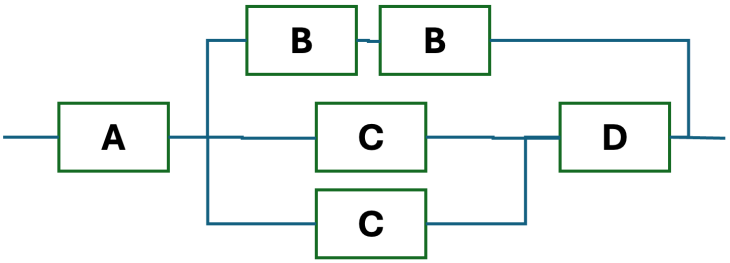


Question 12

We have to design a RAID 0+1 storage architecture composed of an array of 8 disks. Knowing that each disk has a MTTF equal to 450days and that we would like to have a MTTF for the storage infrastructure ($MTTF_{RAID5}$) higher than 7 years, what is the maximum MTTR that we have to consider to satisfy the requirement? Consider all the disks with the same characteristics and a single mirror case for the RAID 1 part.

Question 13
Let us consider a set of requests in the disk queue referring to the following cylinders of the disk: 22, 40, 27, 82, 16. Consider the initial position of the disk head at cylinder 20 and moving from inside (lower cylinder number) to outside (higher cylinder number). Writes the order of the served requests (from the first to the last) if the disk head scheduling algorithm adopted is C-SCAN (Circular SCAN)? Use the cylinder number to refer to the request.

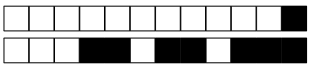
Question 14
Consider a closed system composed of three stations:

- the CPU that is characterized by $V_{CPU} = 3$ visits and an average service time of $S_{CPU} =$ 10ms;
- the disk is characterized by a throughput of X_{DISK}=12 I/O-operations per seconds, and a demand of $D_{DISK} = 350$ms;
- the network whose demand is $D_{NET} = 4$ms, and throughput is X_{NET}=20 packet/s.

When there are $N = 25$ end-users in the system, the system throughput is X=1.85 job/s, and the response time is $R = 0.8$s. Compute the CPU demand and the network number of visits.

Question 15
Considering the same system as in *Questions 14*, what is the users' think time Z?

Question 16
Considering the same system as in *Questions 14 and 15*, and that the number of end-users reaches $N = 50$ in one month. What will be the response time lower bound if you upgrade your system by adding three more disks? You can assume that the new disk is equal to the one initially available and that the original accesses to the disk are now uniformly spread on the set of available disks.



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 and compare virtualization and containerization, discussing their key differences. Highlight the advantages and disadvantages of each approach.

Question 18

⇒ Discuss the role of networking in GPU-based systems within data centers. How does networking impact the performance, scalability, and efficiency of these systems?

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+1/9/52+

Computing Infrastructures - June 12, 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 : $MTTF_A = 18.777$ y

Question 12 : $MTTR = 2.4768$ d

Question 13 : 22 - 27 - 40 - 82 - 16

Question 14 : $D_{CPU} = 0.03$ s, $V_{NET} = 10.81$

Question 15 : $\lambda = 12.7135$ s

Question 16 : $R_{MIN} = 0.384$ s

+2/1/50+

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A False B True

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Question 3 TPUs are more power-efficient and offer higher performance compared to GPUs in deep learning tasks.

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Question 9 The computing continuum refers to the idea that computing devices exist on a spectrum, from small, low-power devices to large, high-performance machines.

A False B True

Question 10 In current datacenters east-west traffic typically involves lower data volumes compared to north-south traffic.

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Exercises

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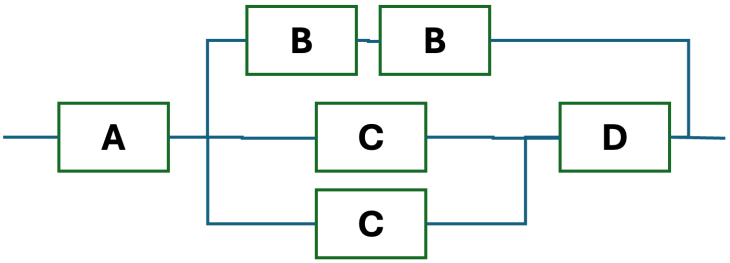

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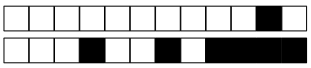
We have to design a RAID 1+0 storage architecture composed of an array of 6 disks. Knowing that each disk has a MTTF equal to 425days and that we would like to have a MTTF for the storage infrastructure ($MTTF_{RAID5}$) higher than 12 years, what is the maximum MTTR that we have to consider to satisfy the requirement? Consider all the disks with the same characteristics and a single mirror case for the RAID 1 part.



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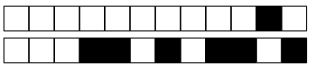

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+2/9/42+

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True/False Questions

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Question 04 : ☒A ☐B

Question 05 : ☒A ☐B

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Question 07 : ☐A ☒B

Question 08 : ☒A ☐B

Question 09 : ☐A ☒B

Question 10 : ☒A ☐B

Exercises

Question 11 : $MTTF_A = 18.777$ y

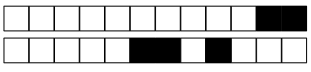
Question 12 : $MTTR = 6.8731$ d

Question 13 : 22 - 27 - 40 - 82 - 16

Question 14 : $D_{CPU} = 0.02$ s, $V_{NET} = 10.8$

Question 15 : $Z = 10$ s

Question 16 : $R_{MIN} = 0.374$ s



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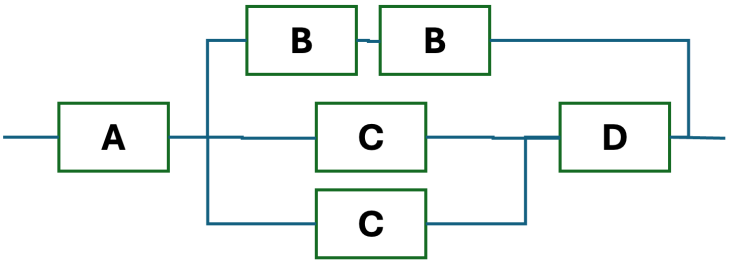

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+3/9/32+

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Question 11 : $MTTF_D = 18.777$ y

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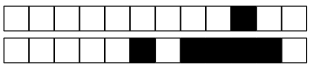

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Question 9 In current datacenters east-west traffic typically involves lower data volumes compared to north-south traffic.

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Question 10 Virtualization can reduce costs by enabling the sharing of hardware resources between virtual machines.

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Exercises

Correct answer: +2, No answer: 0.

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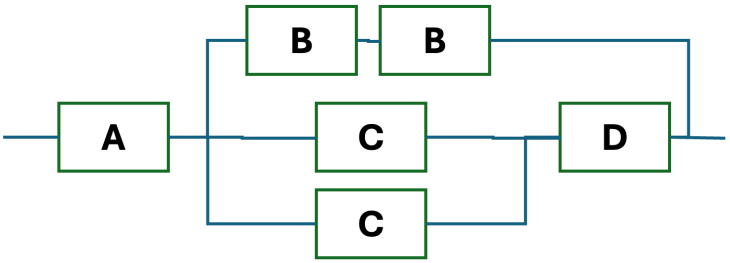


Question 12

We have to design a RAID 0+1 storage architecture composed of an array of 8 disks. Knowing that each disk has a MTTF equal to 450days and that we would like to have a MTTF for the storage infrastructure ($MTTF_{RAID5}$) higher than 7 years, what is the maximum MTTR that we have to consider to satisfy the requirement? Consider all the disks with the same characteristics and a single mirror case for the RAID 1 part.

Question 13
Let us consider a set of requests in the disk queue referring to the following cylinders of the disk: 22, 40, 27, 82, 16. Consider the initial position of the disk head at cylinder 20 and moving from inside (lower cylinder number) to outside (higher cylinder number). Writes the order of the served requests (from the first to the last) if the disk head scheduling algorithm adopted is SCAN? Use the cylinder number to refer to the request.

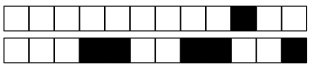
Question 14
Consider a closed system composed of three stations:

- the CPU that is characterized by $V_{CPU} = 3$ visits and an average service time of $S_{CPU} =$ 10ms;
- the disk is characterized by a throughput of X_{DISK}=12 I/O-operations per seconds, and a demand of $D_{DISK} = 350$ms;
- the network whose demand is $D_{NET} = 4$ms, and throughput is X_{NET}=20 packet/s.

When there are $N = 25$ end-users in the system, the system throughput is X=1.85 job/s, and the response time is $R = 0.8$s. Compute the CPU demand and the network number of visits.

Question 15
Considering the same system as in *Questions 14*, what is the users' think time Z?

Question 16
Considering the same system as in *Questions 14 and 15*, and that the number of end-users reaches $N = 50$ in one month. What will be the response time lower bound if you upgrade your system by adding three more disks? You can assume that the new disk is equal to the one initially available and that the original accesses to the disk are now uniformly spread on the set of available disks.



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 and compare virtualization and containerization, discussing their key differences. Highlight the advantages and disadvantages of each approach.

Question 18

⇒ Discuss the role of networking in GPU-based systems within data centers. How does networking impact the performance, scalability, and efficiency of these systems?

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+4/9/22+

Computing Infrastructures - June 12, 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 : $MTTF_A = 18.777$ y

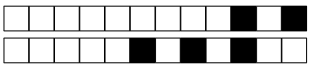
Question 12 : $MTTR = 2.4768$ J

Question 13 : 22 - 27 - 40 - 82 - 16

Question 14 : $D_{CPU} = 0.03$ s, $V_{NET} = 10.81$

Question 15 : $T = 12.7135$ s

Question 16 : $R_{MIN} = 0.386$ s



+5/1/20+

Computing Infrastructures
June 12, 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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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 TPUs are more power-efficient and offer higher performance compared to GPUs in deep learning tasks.

A True B False

Question 2 Controlling humidity levels in a datacenter is important for preventing equipment failures.

A False B True

Question 3 The computing continuum refers to the idea that computing devices exist on a spectrum, from small, low-power devices to large, high-performance machines.

A True B False

Question 4 Virtualization can reduce costs by enabling the sharing of hardware resources between virtual machines.

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Question 6 In-row cooling involves placing cooling units between server racks.

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Question 8 RAID 6 offers better random and sequential write performance than RAID 5.

A False B True

Question 9 In-row cooling systems allow for higher server densities and increased rack power densities in datacenters.

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Question 10 DAS devices connect directly to a network and are accessed over the network by clients.

A True B False

Exercises

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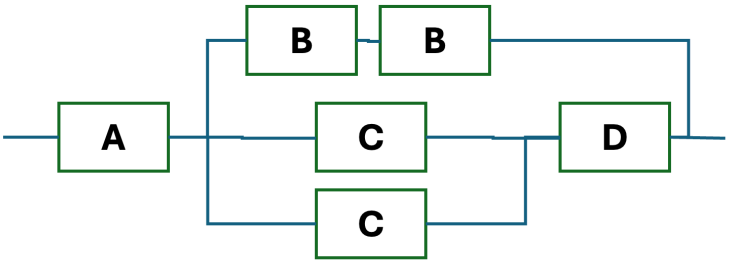
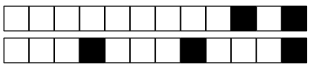


Question 12

We have to design a RAID 1+0 storage architecture composed of an array of 6 disks. Knowing that each disk has a MTTF equal to 425days and that we would like to have a MTTF for the storage infrastructure ($MTTF_{RAID5}$) higher than 12 years, what is the maximum MTTR that we have to consider to satisfy the requirement? Consider all the disks with the same characteristics and a single mirror case for the RAID 1 part.



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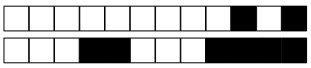

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Question 17

⇒ Explain and compare virtualization and containerization, discussing their key differences. Highlight the advantages and disadvantages of each approach.

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+5/9/12+

Computing Infrastructures - June 12, 2024

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True/False Questions

Question 01 : [X] A [ ] B

Question 02 : [ ] A [X] B

Question 03 : [X] A [ ] B

Question 04 : [ ] A [X] B

Question 05 : [X] A [ ] B

Question 06 : [X] A [ ] B

Question 07 : [X] A [ ] B

Question 08 : [X] A [ ] B

Question 09 : [X] A [ ] B

Question 10 : [ ] A [X] B

Exercises

Question 11 : $MTTF_A = 18,777$ y

Question 12 : $MTTR = 6,8731$ d

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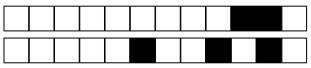
Question 15 : $T = 10$ s

Question 16 : $R_{MIN} = 0,376$ s



Computing Infrastructures
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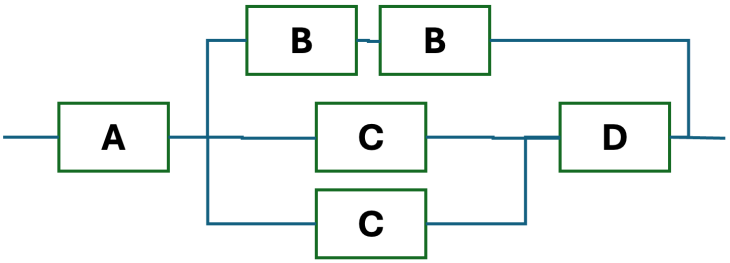

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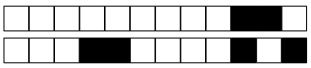

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+6/9/2+

Computing Infrastructures - June 12, 2024

Answer Sheets (Page 3)

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

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Question 07 : [ ] A [X] B

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