Computing Infrastructures
February 7, 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 RAID 5 can handle sequential reads and writes better than RAID 10 with the same amount of disks.

A True B False

Question 2 Monolithic hypervisors are better suited for high-performance computing than microkernel hypervisors.

A True B False

Question 3 Virtualization can help reduce the need for physical space and infrastructure by consolidating multiple servers onto a single physical machine.

A True B False

Question 4 A PUE of 1.0 means that all of the power consumed by a data center is being used by the IT equipment.

A True B False

Question 5 GPUs require specialized software and programming frameworks to fully leverage their parallel processing capabilities.

A True B False

Question 6 Warehouse-scale computers require specialized cooling and power management systems.

A False B True

Question 7 Hot/cold aisle containment reduces the efficiency of the cooling method for datacenters.

A False B True

Question 8 SSDs use spinning disks to store data.

A False B True

Question 9 In a leaf-spine topology, adding or removing a leaf switch does not impact the connectivity of other switches in the network.

A True B False

Question 10 POD, Virtual-Chassis, DCell and BCube models are all evolutions of the leaf-spine network architectures.

A False B True

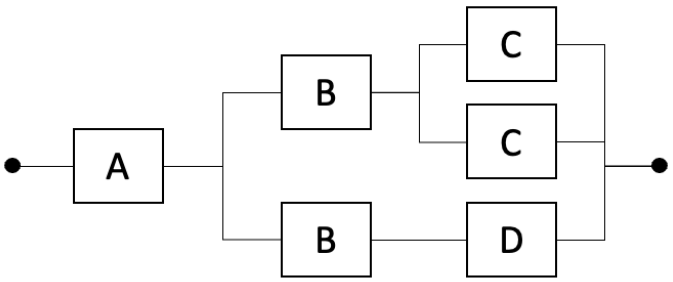
Exercises

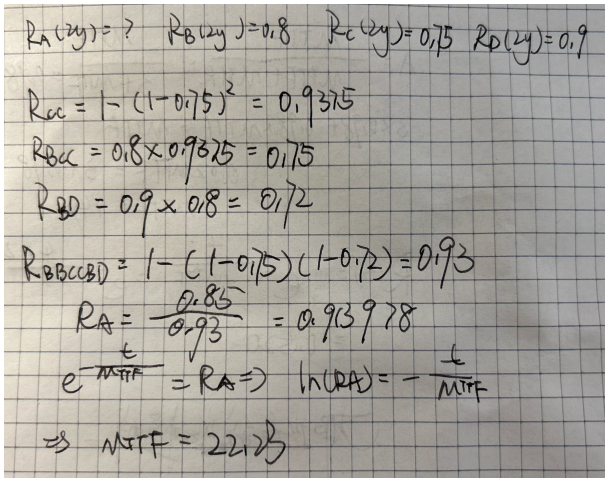
Correct answer: +2, No answer: 0.

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

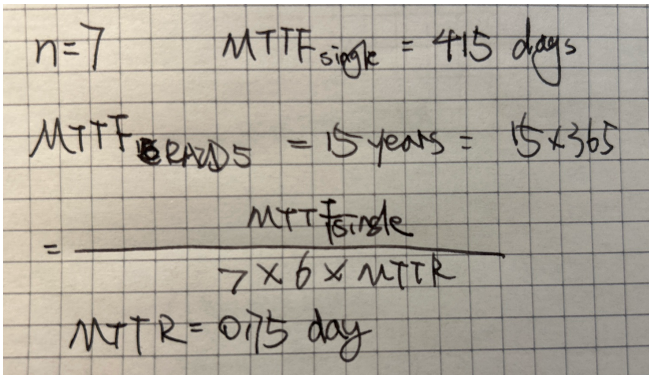
Suppose we have a computer system composed of 6 different components, and designed to have an RBD as shown in the image below. The four types of components (A, B, C, and D) have different reliability characteristics. We know that after 2 years the reliability of components B, C, and D are respectively $R_B(2y) = 0.8$, $R_C(2y) = 0.75$, and $R_D(2y) = 0.9$. What should be the MTTF for component A, if we want to have a Reliability of the whole system after 2 years equal to $R_{sys}(2y) = 0.85$?



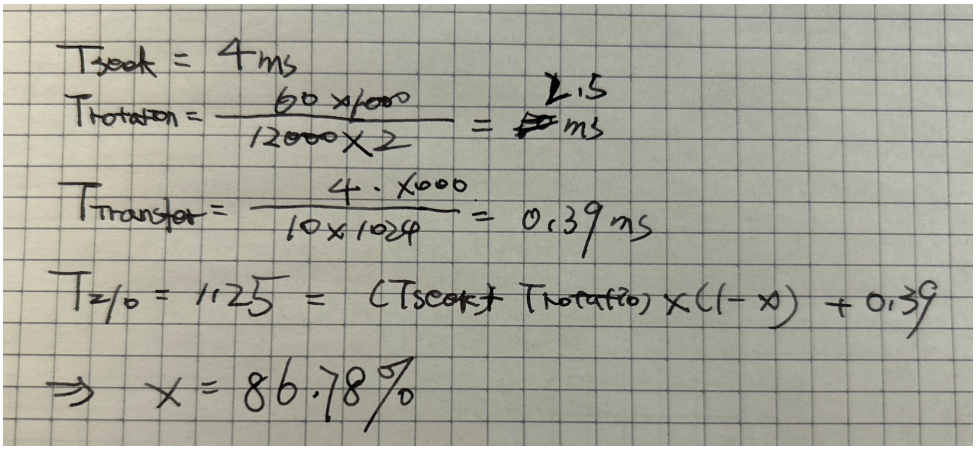


Question 12

We have to design a RAID 5 storage architecture composed of an array of 7 disks. Knowing that each disk has a MTTF equal to 415days and that we would like to have a MTTF for the storage infrastructure ($MTTF_{RAID5}$) higher than 15 years, what is the maximum MTTR that we have to consider to satisfy the requirement? Consider all the disks with the same characteristics.



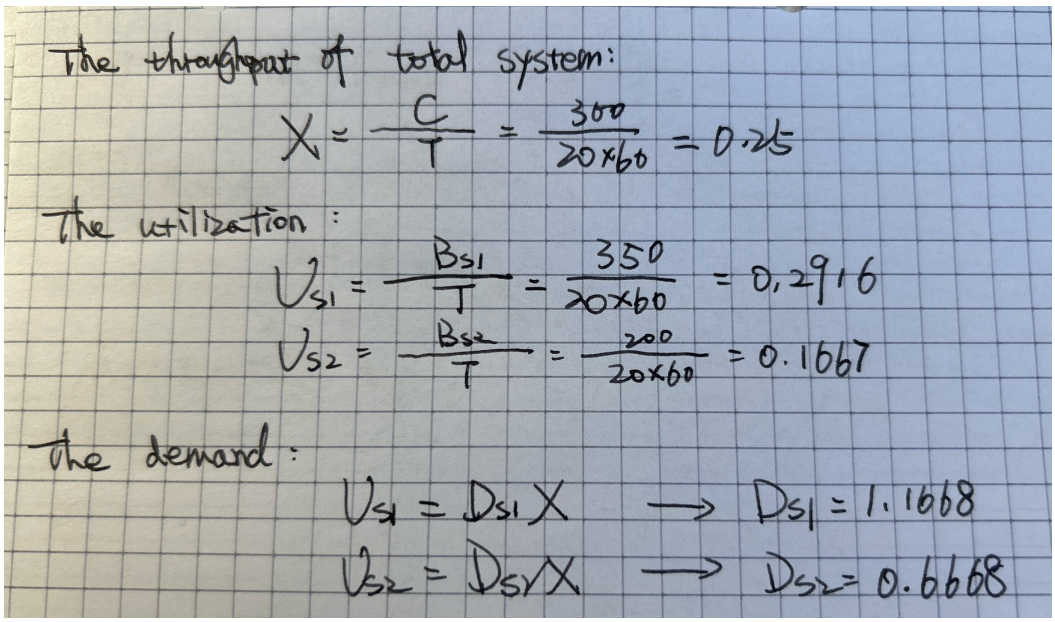
Question 13
Consider an HDD with a data transfer rate of 10 MB/s, a rotation speed of 12000 RPM, a mean seek time of 4 ms, and a negligible overhead controller. What is the minimum locality required to achieve a mean I/O service time of 1.25 ms to transfer a sector of 4 KB?



Question 14
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 initially considered as an open queue network model and the following measurements were obtained during 20-minute monitoring:

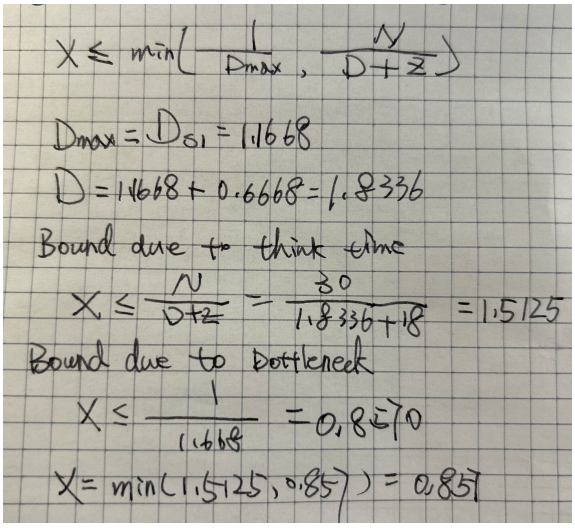
- Number of requests served at the system level: $C = 300$
- Number of requests served by S_1: $C_{S1} = 600$
- Number of requests served by S_2: $C_{S2} = 100$
- Busy time S_1: $B_{S1} = 350$ sec
- Busy time S_1: $B_{S2} = 200$ sec

What are the service demand for S_1 and S_2 (D_{S1} and D_{S2}) and their utilization (U_{S1} and U_{S2})?



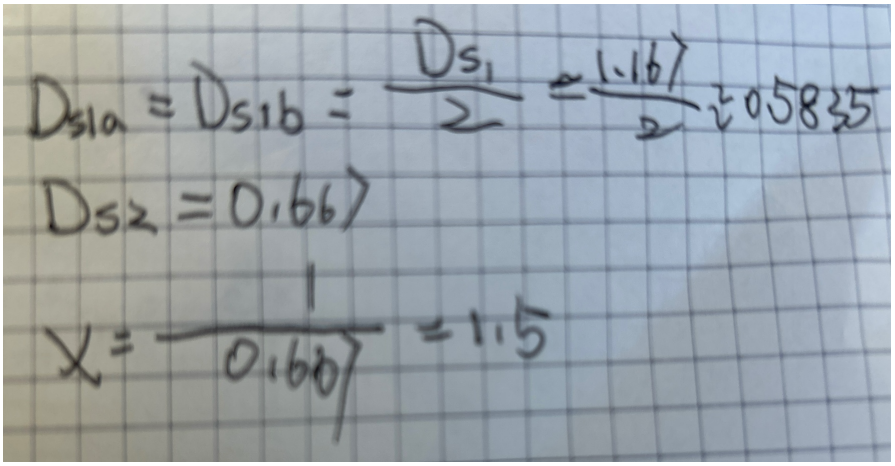
Question 15

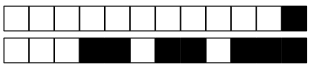
Consider now the same system presented in *Questions 14* as a closed model with a think time Z = 18 sec, and the same values for the demand D_{S1} and D_{S2} calculated in the previous question (open model version). In the context of the asymptotic bounds, what is the system throughput upper bound for N= 30 users?



Question 16

Considering the same system as in *Questions 14 and 15*, if you consider to add another instance of S_1 in the system that equally splits the number of visits with the other S_1 instance, how do the bounds change?





Open Questions

Correct answer: +5, No answer: 0. Points are modulated considering the written text

Write the answer using ONLY the space available in the boxes on the ANSWER SHEETS. The answers should be readable by the professor. Unreadable answers will be considered wrong.

Question 17

⇒ In the context of Virtualization, describe a Type 2 hypervisor providing also advantages and drawbacks?

Question 18

⇒Provide the definition of *Geographic Areas*, *Compute Regions*, and *Availability Zones* in the context of data centers. What are the advantages and drawbacks of placing all compute instances for my service within a single availability zone?

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

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

+1/7/54+

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Answer Sheets (Page 1)

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

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Question 17

⇒ In the context of Virtualization, describe a Type 2 hypervisor providing also advantages and drawbacks?

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Answer Sheets (Page 2)

Question 18

⇒Provide the definition of *Geographic Areas*, *Compute Regions*, and *Availability Zones* in the context of data centers. What are the advantages and drawbacks of placing all compute instances for my service within a single availability zone?

+1/9/52+

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Answer Sheets (Page 3)

Student ID (Codice Persona): S02

True/False Questions

Question 01 : [X] A [ ] B

Question 02 : [X] A [ ] B

Question 03 : [X] A [ ] B

Question 04 : [X] A [ ] B

Question 05 : [X] A [ ] B

Question 06 : [ ] A [X] B

Question 07 : [X] A [ ] B

Question 08 : [X] A [ ] B

Question 09 : [X] A [ ] B

Question 10 : [X] A [ ] B

Exercises

Question 11 : 22,23 Y

Question 12 : 0,75 DAYS

Question 13 : 86,78 %

Question 14 : $D_{S1} = 1,16$ sec / $D_{S2} = 0,65$ sec / $U_{S1} = 23,17\%$ / $U_{S2} = 16,6\%$

Question 15 : $X_{MAX} = 0,875$ J/S

Question 16 : $X_{MAX} = 1,5$ J/S