Computing Infrastructures
January 24, 2023

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 15min

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 Sheet. 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, on the first and last page of the exam. **Do not write your name on the first page of the Answer Sheet**. It is requested only the personal code.

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

Do not use crosses to mark the answers, **fill clearly the box you selected** 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 to write the formulas and procedure used to solve the problem just after the question in the left space. Only the numeric answer and its unit should be reported on the corresponding dotted line in the Answer Sheet.

The answer to *Question 17* should be written using ONLY the space available on Page 2 of the Answer Sheet. The answer should be readable by the professor. Unreadable answers will be considered wrong.

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.
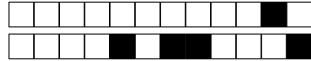
Multiple choice questions
Correct answer: +2, No answer: 0, Wrong Answer -0.5

Answers must be given on the ANSWER SHEET. Any box filled here will be ignored.

Question 1   In a three-layer network architecture of a Datacenter, which is the layer that is typically associated to the TOR switch?

A Access

B Core

C Aggregation

D None of the others

Question 2
Which sentence about Tier Level 4 of datacenter is not correct?

A Fault-tolerant site infrastructure with availability of 99.995%

B Meets or exceeds all Tier 3 requirements

C Single non-redundant distribution path serving the IT equipment

D All cooling equipment is independently dual-powered

Question 3
Which is the main characteristic of the D-Cell topology for data center network architectures?

A the network is organized in a recursive way

B The network comprises edge, aggregation and core layers

C the network is organized in a hierarchical way

D The network is organized in a distributed way

Question 4
What is a hybrid cloud computing system?

A a cloud used for a single organization

B a cloud whose energy is produced both by diesel and batteries

C a cloud shared by several organization

D a cloud composed by private and public cloud systems

True false questions

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

Answers must be given on the ANSWER SHEET. 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 5

Paravirtualization cannot be used with unmodified OS

[A] True   [B] False

Question 6

Servers in data centers are like regular personal-computers with the same form factor

[A] False   [B] True

Question 7

Warehouse-scale computers run a large number of very small applications

[A] False   [B] True

Question 8

In datacenter storage context, DAS means Distributed Application Storage:

[A] False   [B] True

Question 9

An Edge Computing system provides higher performance (in terms of memory and computation) than Internet-of-Things devices:

[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 SHEET. 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 10

A system is composed of two components in parallel. The reliability for a single component measured at t=5 days is R(5 days)=0.98. What is the maximum number of consecutive days for which the system has a probability higher than 0.85 to work without faults?

Question 11

The analysis of the failure behavior of a three-component system (A, B and C) reveals that the system is down when one between A and B is down, and C is down. The three components have the following characteristics: $MTTF_A = 80days$, $MTTR_A = 1day$, $MTTF_B = 12days$ and $MTTR_B = 12hour$, $MTTF_C = 120days$, $MTTR_C = 2.5days$. What is the average availability of the system?
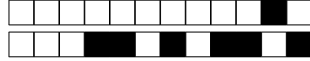
Question 12

Consider an HDD with, 4KB as block size, a rotation speed of 10000 RPM, 0.4 ms as transfer time for 1 block, 6 ms as average seek time, and a negligible overhead of the controller. Knowing that the average locality of the accesses is 95%, what is the average I/O time to access a 480KB file?

Question 13

A RAID 5 system uses four 2TB disks to store data and the required parity bits. Considering that each disk has a Sequential Access Speed (Throughput) of 85MB/s and a Random Access Speed (Throughput) of 8.5MB/s, what is the expected throughput of the RAID 5 considering a random read pattern?
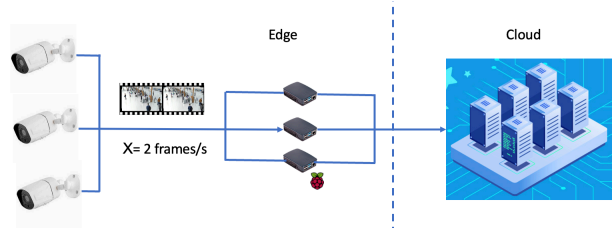
Question 14

Consider the following RAID 5 setup having an MTTF_{RAID5} (also called MTTDL) equal to 6.5 years. The storage architecture is composed of 8 disks; each disk has an MTTF equal to 2 years. What is the average MTTR of each disk used within the storage architecture?

Question 15

You have to develop a cloud-edge system for video surveillance. In the edge network, you can install a cluster of RaspberryPi which is used to performs, for privacy reasons, a local initial processing of each video frame. Given the limited computing capability of the RaspberryPis the final processing of each frame is performed in a cloud cluster based on standard Virtual Machines. The input frame rate of the images coming from the cameras is 2 frame/s, the demanding time to process each frame on a RaspberryPi is 0.4s while the demanding time on a VM is 0.6s. In presence of multiple RaspberryPi nodes and/or VMs, the demand to process each frame is equally split among them. Determine the minimum number of edge (N_{RPi}) and cloud nodes (N_{VM}) such that the maximum utilization on the edge is less or equal to 0.3 while in the cloud the maximum utilization is less or equal to 0.5.

Question 16

Assuming that in the system described in the previous exercise you have installed 4 RasberryPis and 4 VMs, determine the lower bound of the system response time for frame processing, assuming you can model the system as a closed queuing network serving N=50 batch jobs (i.e., 50 cameras are connected overall and think time Z=0).

Open Question

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

Write the answer using ONLY the space available on Page 2 of the Answer Sheet. The answer should be readable by the professor. Unreadable answers will be considered wrong.

Question 17

⇒ What is the role of hardware accelerators in datacenters?

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

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

Computing Infrastructures - Answer Sheet (Page 1)
January 24, 2023

Student id (codice persona): **SOLUZIONE**

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Multiple Choice Questions

Question 01 : ☒ A ☐ B ☐ C ☐ D

Question 02 : ☐ A ☐ B ☒ C ☐ D

Question 03 : ☒ A ☐ B ☐ C ☐ D

Question 04 : ☐ A ☐ B ☐ C ☒ D

True/False Questions

Question 05 : ☒ A ☐ B

Question 06 : ☒ A ☐ B

Question 07 : ☒ A ☐ B

Question 08 : ☒ A ☐ B

Question 09 : ☒ A ☐ B

Exercises

Question 10 : $T \simeq 121 \text{ DAYS}$ $M_{TTF} = -\dfrac{5}{\ln 0.98} \Rightarrow R_{//} = 1-(1-R_{SINGLE})^2$ $R_{SINGLE} = e^{\frac{-t}{MTTF}}$

Question 11 : $A_V = 0,99834$ $A_{V.TOT} = 1-(1-A_{VA}A_{VB})(1-A_{VC})$

Question 12 : $T_{V_0} = 102 \text{ msec}$ $T_{V_0} = \#\text{BLOCKS} * 0.4 \text{ ms} + 6 (3+6)$
(120) T_T $(120*0.05)$ $T_{TOT} \; T_{SEEK}$

Question 13 : $34 \text{ MB/s} = R*N$

Question 14 : $MTTR \simeq 4 \text{ DAYS or } 0.011 \text{ YEARS}$ $MTTR = \dfrac{MTTF^2}{MTTF*N*N-1}$ RAID5

Question 15 : $N_{RP_1} \geq 3$ $N_{VM} \geq 3$ $U_{RP_1} \leq X \dfrac{D_{RP_1}}{N_{RP_1}}$ THE SAME FOR VMs

Question 16 : $R_{T_{MAX}} = MAX(D, N D_{MAX}) = 7,5 \text{ SEC}$
$0,4+0.6$ $50 * \dfrac{0.6}{4}$