Student ID (*Matricola*)

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8	8	8	8	8	8
9	9	9	9	9	9

Computing Infrastructures

Course 095897

P. Cremonesi, M. Roveri

Example exam

Last Name / Cognome:

....

First Name / Nome:

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Answers must be given exclusively on the answer sheet (last sheet): DO NOT FILL ANY BOX IN THIS SHEET

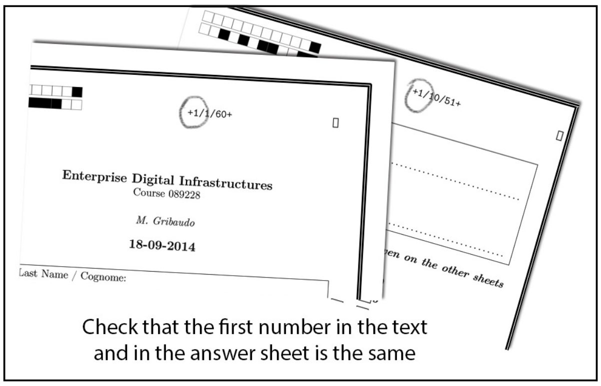
Students must use pen (black or blue) to mark answers (no pencil).
Students are permitted to use a non-programmable calculator.

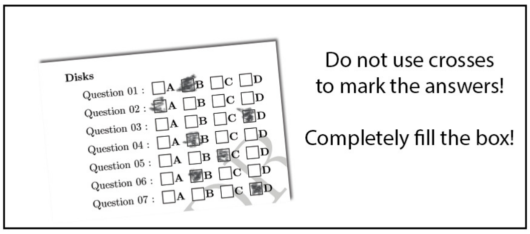
Students are NOT permitted to copy anyone else's answers, pass notes amongst themselves, or engage in other forms of misconduct at any time during the exam.

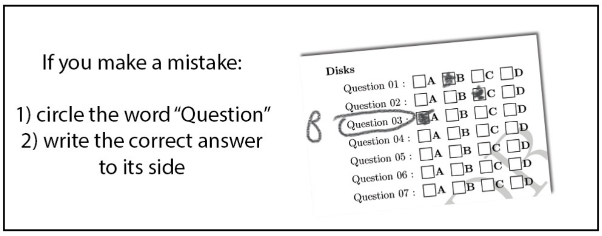
Students are NOT permitted to use mobile phones and similar connected devices.

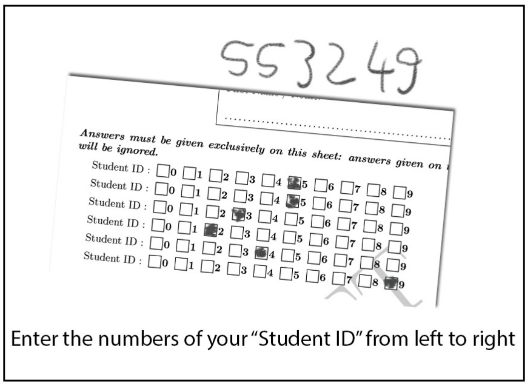
Scores: correct answers +1.5 point, unanswered questions 0 points, wrong answers -0.5 points.

Questions will multiple answers will be considered as not answered (0 points).









Question 1 Which is the configuration characterizing the three-layers network architecture of a data-center?

- A Access – Fog – Core
- ■ Access – Aggregation – Core
- C Sensors – Aggregation – Cloud
- D Access- Aggregation – Cloud

Question 2 Which module is not typically present in the racks of a DataCenter?

- A Power distribution units
- B Storage units
- ■ Embedded systems
- D Servers

In the following questions we will assume that both failure and repair events follow exponential distributions.

Question 3
Let us now consider a generic component D. Compute the minimum integer value of $MTTF_D$ in order to have at $t = 10\ days$ a reliability $R_D(t) \geq 0.93$.

A 10 B 55 ■ 138 D 74

Explanation: $R_D(t) \geq 0.93$ $e^{-t/MTTF_D} \geq 0.93$ $-t/MTTF_D \geq ln(0.93)$
$MTTF_D \geq -t/ln(0.93)$

Question 4
Consider a system built by two different components in parallel. Assume for component A: $MTTF_A = 177\ days$ and $MTTR_A = 7\ days$ and for component B: $MTTF_B = 230\ days$ and $MTTR_B = 12\ days$. The availability of the whole system is equal to:

A 0.956185 ■ 0.998114 C None of the others D 0.914256

Explanation: $A_A = MTTF_A/(MTTF_A + MTTR_A) = 0.96196$
$A_B = MTTF_B/(MTTF_B + MTTR_B) = 0.95041$
$A_{sys} = 1 - (1 - A_A) * (1 - A_B) = 0.998114$

Question 5
Consider a system built by two different components in parallel. Assume for component A: $MTTF_A = 205\ days$ and $MTTR_A = 1\ days$ and for component B: $MTTF_B = 485\ days$ and $MTTR_B = 5\ days$.
The reliability of the system at $t = 6\ days$ is equal to:

- [A] 0.991342
- ■ 0.999645
- [C] 0.989069
- [D] 0.987705

Explanation: $R_A(t) = e^{-t/MTTF_a}$ $R_B(t) = e^{-t/MTTF_b}$ $R_{sys}(t) = 1 - (1 - R_A(t)) * (1 - R_B(t))$

Question 6 A system is composed by 2 physical machines (Host1, Host2), with subnet addresses: 192.168.0.1 and 192.168.0.2 (default subnet mask: 255.255.255.0). Two Virtual Machines, VM1 and VM2 run over Host1, connected in NAT mode. Other two Virtual Machines, VM3 and VM4 run over Host2, connected in bridged mode. Assuming that port-forwarding is configured to map port X of the guest on the same port X on the host:

- [A] a service running inside VM3 and listening on port 22 can be reached at the address: 192.168.0.2:22
- [B] 192.168.0.3 is a possible IP address for VM1 on the hosts' subnet
- [C] VM3 and VM4 are not reachable by Host1
- ■ a service running inside VM2 and listening on port 8080 can be reached at the address: 192.168.0.1:8080

Explanation: No port-forwarding is required for VM3 and VM4, as they have IP addresses on the same subnet: 192.168.0.Y, reachable from Host1. Moreover, VM1 is NATted, so a service it hosts on port X can be reached at: 192.168.0.1:X

Question 7 In memory virtualization, "ballooning" is a technique that:

- [A] does not require support from the Guest OS
- [B] separates user logical memory from physical memory
- ■ allows the VMM to ask guest VMs to release memory pages
- [D] implies that the VMM determines the pages that are less used

Explanation: Lesson_3_Virtualization_B.pdf, slide 18

Question 8 With Bridged Networking:

- ■ guests behave as physically connected to the network interface
- [B] port-forwarding rules must be set to expose VM's ports on the network
- [C] requires the VMM to keep an internal table to map requests from and responses to each VM
- [D] the VMM provides an IP address to the VM

Explanation: Lesson_3_Virtualization_B.pdf, slide 56

Question 9
Consider a HDD with:

- block size: 3 KB
- mean I/O service time per block (with no locality): 9.0 ms
- transfer time of 1 block: 0.08 ms
- overhead controller: 0.2 ms

How long does it take to transfer a file of 130 MB if we assume a locality of: 60%?

■ 167.20 s [B] 172.17 s [C] 399.36 s [D] none of the others

Explanation: Total number of blocks to be transferred: 130*1024KB/(3 KB/block) = 44373 blocks
44373*(1-0.60)*9.0ms + 44373*(0.60)*(0.2ms+0.08ms) = 167.20 s

Question 10
Consider 2 groups (RAID 0) of 2 disks each (RAID 1), for a total of 4 disks in configuration RAID 1+0:

- MTTR = 3 days
- MTTF(one disk) = 1400 day

The MTTDL will be:

[A] none of the others [B] 326667 days [C] 326667 days ■ 163333 days

Explanation: $MTTDL = MTTF^2/(totaldisks * MTTR)$ = 163333 days (MTTDL is the same for any couple of disks (data and mirror) of the array)

Question 11
Consider the following RAID 0 setup:

- n = 5 disks
- MTTR = 8 hours
- MTTF(one disk) = 1600 day

The MTTDL will be:

■ 320 days B 200 days C 320 hours D none of the others

Explanation: MTTDL = MTTF(1 disk) / n = 320 days (as MTTDL does not depend on MTTR)

Question 12
Consider a closed system with the following data: average number of users: 23 ($N = 23$) average response time: 28 sec ($R = 28$), average throughput: 0.42 trans/sec ($X = 0.42$), average CPU service demand: 0.60 sec/trans ($D_{\text{CPU}} = 0.60$). Which is the average think time Z of a user?

A 10.33 sec B 38.33 sec C 54.76 sec ■ 26.76 sec

Explanation: Z = N/X - R

Question 13

Consider the following measurement data for an interactive system

- measurement interval: 5 minutes
- number of users: 47
- number of servers: 23
- average response time per transaction: 19 seconds
- Dmax 1.2 sec/transaction
- Dtot 1.2 sec/transaction
- number of completed transactions: 76

On average, how many users are thinking?

A 18.12   B 4.81   ■ 42.19   D 22.56

Explanation: Nthink = N - Nnot-think
Nnot-think = X R
X = C / T

Question 14
By monitoring a single class iteractive system, we are able to measure the following data:

- Monitoring period: 5 minutes
- Disk utilization: 0.25
- CPU utilization: 0.64
- CPU demand: 0.38 seconds/transaction
- Number of I/O operations / transaction 11
- Response time: 20 seconds/transaction
- Number of users: 44

Which is the average think time of these users?

■ 6.13 sec　　B 3.26 sec　　C 26.13 sec　　D 5.44 sec

Explanation: Z = N/X - R
X = Ucpu / Dcpu

Question 15
Consider a single-class multi station system with two stations. We have the following information about the system:

- station 1 response time: 12 seconds
- station 2 response time: 4 seconds
- station 1 throughput: 3 transactions/second
- station 2 throughput: 5 transactions/second
- system throughput: 3 transactions/second

Which is the average response time of the system?

A 16.00 sec　　B 16.12 sec　　C 0.89 sec　　■ 18.67 sec

Explanation: V1 = X1 / X
V2 = X2 / X
R1 = r1 V1
R2 = r2 V2
R = R1 + R2

Question 16
Consider a closed system with the following data: average number of users: 19 ($N = 19$) average response time: 40 sec ($R = 40$), average throughput: 0.47 trans/sec ($X = 0.47$), average CPU service demand: 0.78 sec/trans ($D_{\text{CPU}} = 0.78$). Which is the CPU utilization?

[A] 0.53 [B] 0.02 [C] 0.63 ■ 0.37

Explanation: Ucpu = X*Dcpu

Question 17
Consider a closed queuing network with the following characteristics:

- number of stations K = 5
- service demand Dmax = 1.1
- service demand Dtot = 1.9
- think time Z = 2
- number of users N = 4

Which is the asymptotic lower bound of response time?

[A] 1.46 sec [B] 1.52 sec [C] 1.26 sec ■ 2.40 sec

Explanation: $\max(D, ND_{max} - Z) = \max(1.9, 4 \times 1.1 - 2) = 2.40$

Question 18
Consider a closed queuing network with the following characteristics:

- number of stations K = 5
- service demand Dmax = 0.6
- service demand Dtot = 0.7
- think time Z = 1
- number of users N = 4

Which is the asymptotic lower bound of throughput?

■ 1.05 tran/sec B 1.67 tran/sec C 1.43 tran/sec D 0.79 tran/sec

Explanation: $\frac{N}{ND+Z} = \frac{4}{4\times 0.7+1} = 1.05$

Question 19
Consider a closed queuing network with the following characteristics:

- number of stations K = 3
- service demand Dmax = 1.0
- service demand Dtot = 2.9
- think time Z = 3
- number of users N = 3

Which is the asymptotic upper bound of response time?

A 0.00 sec B 4.47 sec C 4.49 sec ■ 8.70 sec

Explanation: $ND = 3 \times 2.9 = 8.70$

Question 20
Consider a closed queuing network with the following characteristics:

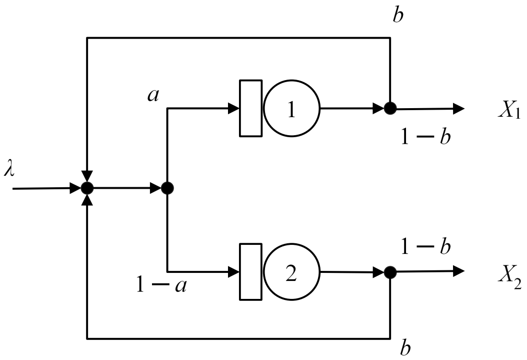
- number of stations K = 1
- service demand Dmax = 1
- service demand Dtot = 1
- think time Z = 2
- number of users N = 4

Which is the asymptotic upper bound of throughput?

[A] 2 tran/sec ■ 1 tran/sec [C] 0.667 tran/sec [D] 0.8 tran/sec

Explanation: $\min(\frac{N}{D+Z}, \frac{1}{D_{max}}) = \min(\frac{4}{2.6+1}, \frac{1}{1.8}) = 0.56$

Question 21 Consider the following open network, where a and b are routing probabilities. Which is the number of visits at station 1?



[A] $a * b$ ■ $a/(1-b)$ [C] $a+b$ [D] a

Explanation: V1 = a*(1 + V1*b + V2*b) = a*[1 + b*(V1 + V2)]
V2 = (1-a)*(1 + V1*b + V2*b) = (1-a)*[1 + b*(V1 + V2)]
V2/V1 = (1 - a)/a = 1/a - 1
V2 = V1/a - V1
V1 = a*(1 + b*V1/a) = a + V1*b
V1*(1 - b) = a

Question 22
Consider a single-class open queuing network with the following characteristics:

- Visits station A (Va): 1.1
- Visits station B (Vb): 0.7
- Service time station A (Sa): 0.25 sec/tran
- Service time station B (Sb): 0.25 sec/tran
- Arrival rate (λ): 1.62 tran/sec

The system response time $R(\lambda)$ is:

■ 0.750 sec/tran B 0.794 sec/tran C 0.460 sec/tran D 1.175 sec/tran

Explanation: $R(\lambda) = \frac{D_a}{1-U_a} + \frac{D_b}{1-U_b} = \frac{S_a V_a}{1-\lambda S_a V_a} + \frac{S_b V_b}{1-\lambda S_b V_b} = \frac{0.25\times 1.1}{1-1.62\times 0.25\times 1.1} + \frac{0.25\times 0.7}{1-1.62\times 0.25\times 0.7} = 0.750$

Answer sheet:

Last Name / Cognome:

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First Name / Nome:

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Answers must be given exclusively on this sheet: answers given on the other sheets will be ignored.

Student ID : ☐0 ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9

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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

Question 05 : ☐A ■B ☐C ☐D

Question 06 : ☐A ☐B ☐C ■D

Question 07 : ☐A ☐B ■C ☐D

Question 08 : ■A ☐B ☐C ☐D

Question 09 : ■A ☐B ☐C ☐D

Question 10 : ☐A ☐B ☐C ■D

Question 11 : ■A ☐B ☐C ☐D

Question 12 : ☐A ☐B ☐C ■D

Question 13 : ☐A ☐B ■C ☐D

Question 14 : ■A ☐B ☐C ☐D

Question 15 : ☐A ☐B ☐C ■D

Question 16 : ☐A ☐B ☐C ■D

Question 17 : ☐A ☐B ☐C ■D

Question 18 : ■A ☐B ☐C ☐D

Question 19 : ☐A ☐B ☐C ■D

Question 20 : ☐A ■B ☐C ☐D

Question 21 : ☐A ■B ☐C ☐D

Question 22 : ■A ☐B ☐C ☐D