+72/1/40+

Student ID (*Matricola*)

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Computing Infrastructures

Course 095897

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12-09-2018

Last Name / Cognome:

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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

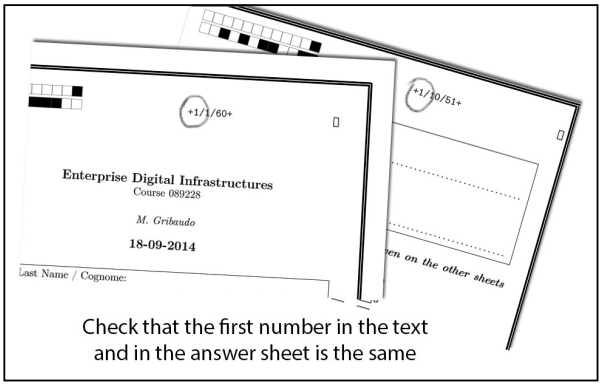
Students must use pen (black or blue) to mark answers (no pencil).
Students are permitted to use a non-programmable calculator.

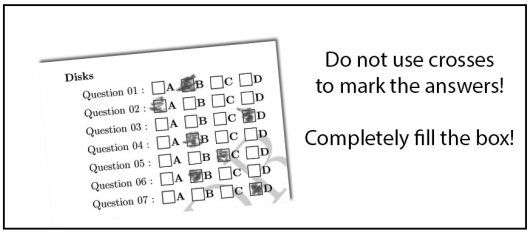
Students are NOT permitted to copy anyone else's answers, pass notes amongst themselves, or engage in other forms of misconduct at any time during the exam.

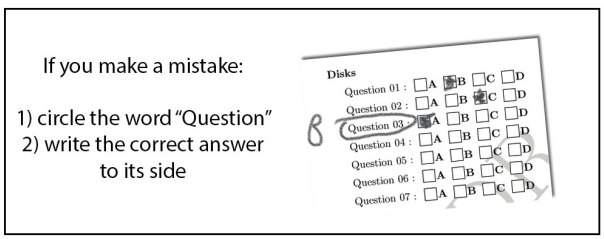
Students are NOT permitted to use mobile phones and similar connected devices.

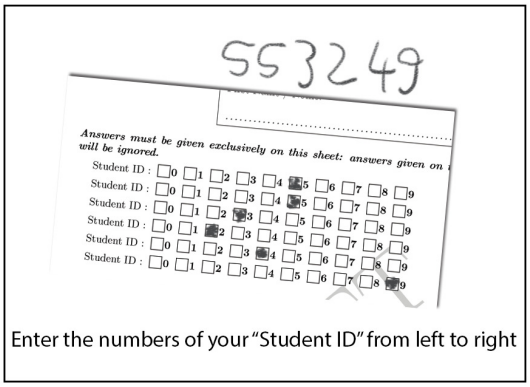
Scores: correct answers +1.5 point, unanswered questions 0 points, wrong answers -0.5 points.

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









Question 1 In the Microkernel architecture of VMs:

A Drivers are part of the Guest VMs

B Drivers are part of the Hypervisor

■ Drivers are part of a specific service VM

D Drivers are part of the Guest Oss

Explanation:

Question 2 Which statement about Platform as a Service is not correct?

A PaaS provides developers with a programming-language-level environment and API

■ Gmail is an example of PaaS

C PaaS accelerates the deployment

D PaaS supports the scalability

Explanation:

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

Question 3
A server with two processors and a single hard disk is considered. The two processors are in parallel together followed in series by the hard disk. Both processors have the following characteristics: $MTTF_{Pr} = 500\ days$, $MTTR_{Pr} = 5\ days$. The parameters of the hard disk are: $MTTF_{HD} = 700\ days$, $MTTR_{HD} = 3\ days$. The availability of the whole system is equal to:

■ 0.99563 B 0.99010 C 0.99573 D 0.99990

Explanation:
$A_{Pr} = 500/(500 + 5) = 0.99010$
$A_{HD} = 700/(700 + 3) = 0.99573$
$A_{||} = 1 - (1 - A_{Pr})^2 = 0.99990$
$A_{sys} = A_{||}A_{HD} = 0.99563$

Question 4
A server with two processors and a single hard disk is considered. The two processors are in parallel together followed in series by the hard disk. Both processors have the following characteristics: $MTTF_{Pr} = 400\ days$, $MTTR_{Pr} = 5\ days$. The parameters of the hard disk are: $MTTF_{HD} = 600\ days$, $MTTR_{HD} = 2\ days$. The MTTF computed without repair of the whole system is:

A 360000 ■ 300 C 600 D 1200

Explanation:
$MTTF_{||} = 400 * (1 + 1/2) = 600$
$MTTF_{Sys} = 1/(1/MTTF_{||} + 1/MTTF_{HD}) = 1/(1/600 + 1/500) = 300$

Question 5 To increase reliability, which of the following actions is not correct?

- [A] Use multiple redundant components
- [B] Have spare components at disposal
- [■] Use elements with low MTTF
- [D] Reduce MTTR to a minimum

Explanation:
You must use elements with high MTTF

Question 6 With Bridged Networking:

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

Explanation:
Lesson_3_Virtualization_B.pdf, slide 56

Question 7 Consider 5 Virtual Machines (VMs) on 4 different Physical Machines (Hosts):

- Host1 @ 192.168.0.1 runs VM1 and VM2, connected with internal networking;
- Host2 @ 192.168.0.2 runs VM3, attached to its Bridge adapter;
- Host3 @ 10.0.0.1 runs VM4, attached to the NAT adapter;
- Host4 @ 10.0.0.2 runs VM5, attached to the NAT adapter;

Assuming that the network connecting all the hosts is configured to enable them to see each others (i.e.: Host1 can see Host3):

■ a service on VM4 can reach a service on VM5 if port-forwarding is configured for VM5 but not for VM4

B none of the other answers is valid

C a service on VM1 can reach a service on VM4 if port-forwarding is configured for VM4

D port-forwarding needs to be configured to expose services running on VM2

Explanation:
Services running on VM1 and VM2 cannot be accessed from outside and cannot reach the external network; with NAT, a VM can reach the outside network even if port-forwarding is not enabled for itself, while it has to be enabled to receive connections from outside.

Question 8 In memory virtualization:

■ shadow pages are maintained by the VMM

B none of the other answers is valid

C the support of the Guest OS is required for memory overcommit

D the MMU causes a trap if a memory page is already in RAM

Explanation:
Lesson_3_Virtualization_B.pdf, multiple slides on memory virtualization

Question 9
Consider a HDD with:

- block size: 2 KB
- mean I/O service time per block (with no locality): 11.6 ms
- transfer time of 1 block: 0.09 ms
- overhead controller: 0.3 ms

How long does it take to transfer a file of 100 MB if we assume a locality of: 60%?

[A] 257.54 s	[■] 249.55 s	[C] none of the others	[D] 593.92 s

Explanation:
Total number of blocks to be transferred: 100*1024KB/(2 KB/block) = 51200 blocks
51200*(1-0.60)*11.6ms + 51200*(0.60)*(0.3ms+0.09ms) = 249.55 s

Question 10
Consider 3 groups (RAID 0) of 2 disks each (RAID 1), for a total of 6 disks in configuration RAID 1+0:

- MTTR = 3 days
- MTTF(one disk) = 1700 day

The MTTDL will be:

[A] 818833333 days	[B] none of the others	[■] 160556 days	[D] 545888889 days

Explanation:
$MTTDL = MTTF^2/(totaldisks * MTTR)$ = 160556 days (MTTDL is the same for any couple of disks (data and mirror) of the array)

Question 11
Consider the following RAID 6 setup:

- n = 5 disks
- MTTR = 2 days
- MTTF(one disk) = 1000 day

The MTTDL will be:

A none of the others	B 16667 days	■ 8333333 days	D 41666667 days

Explanation:
$MTTDL = 2 * MTTF^3/(n * (n-1) * (n-2) * MTTR^2) = 8333333 days$

Question 12
Consider a single-class multi station system with two stations. We have the following information about the system:

- station 1 response time: 11 seconds
- station 2 response time: 1 seconds
- station 1 throughput: 4 transactions/second
- station 2 throughput: 6 transactions/second
- system throughput: 3 transactions/second

Which is the average response time of the system?

A 1.11 sec	B 9.12 sec	C 12.00 sec	■ 16.67 sec

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

Question 13
By monitoring a single class iteractive system, we are able to measure the following data:

- Monitoring period: 5 minutes
- Disk utilization: 0.31
- CPU utilization: 0.58
- CPU demand: 0.37 seconds/transaction
- Number of I/O operations / transaction 11
- Response time: 17 seconds/transaction
- Number of users: 42

Which is the average think time of these users?

A 5.25 sec B 7.80 sec ■ 9.79 sec D 26.79 sec

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

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

- Monitoring period: 100 seconds
- CPU service time: 0.32 seconds/operation
- CPU utilization: 0.51
- Disk throughput: 6 operations/second
- Disk visits: 13 operations/transaction
- Response time: 1.9 seconds/transaction
- Number of users: 47

Which is the average think time of these users?

[A] 98.10 sec [B] 5.93 sec [C] 101.83 sec ■ 99.93 sec

Explanation:
X = Xdisk / Vdisk = 0.461538461538461538
Z = N/X - R = 99.93

Question 15
Consider the following measurement data for an interactive system

- measurement interval: 5 minutes
- number of users: 51
- number of servers: 16
- average response time per transaction: 19 seconds
- Dmax 1.9 sec/transaction
- Dtot 3.0 sec/transaction
- number of completed transactions: 76

On average, how many users are thinking?

■ 46.19 B 25.73 C 4.81 D 22.12

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

Question 16
Consider a closed system with the following data: average number of users: 24 ($N = 24$) average response time: 28 sec ($R = 28$), average throughput: 0.41 trans/sec ($X = 0.41$), average CPU service demand: 0.65 sec/trans ($D_{\mathrm{CPU}} = 0.65$). Which is the average think time Z of a user?

A 36.92 sec B 58.54 sec ■ 30.54 sec D 8.92 sec

Explanation:
Z = N/X - R

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

- service demand Dmax = 1.1 sec
- service demand Dtot = 2.8 sec
- think time Z = 0.5 sec
- number of users N = 4

Which is the asymptotic upper bound of response time?

A 7.35 sec B 9.17 sec C 3.90 sec ■ 11.20 sec

Explanation:
$ND = 4 \times 2.8 = 11.20$

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

- service demand Dmax = 1.1 sec
- service demand Dtot = 1.7 sec
- think time Z = 1 sec
- number of users N = 4

Which is the asymptotic lower bound of throughput?

■ 0.51 tran/sec B 0.41 tran/sec C 0.59 tran/sec D 0.91 tran/sec

Explanation:
$\frac{N}{ND+Z} = \frac{4}{4 \times 1.7+1} = 0.51$

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

- service demand Dmax = 2.1 sec
- service demand Dtot = 8.6 sec
- think time Z = 1 sec
- number of users N = 4

Which is the asymptotic upper bound of throughput?

A 0.48 tran/sec ■ 0.42 tran/sec C 0.47 tran/sec D 1.90 tran/sec

Explanation:
$\min(\frac{N}{D+Z}, \frac{1}{D_{max}}) = \min(\frac{4}{8.6+1}, \frac{1}{2.1}) = 0.42$

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

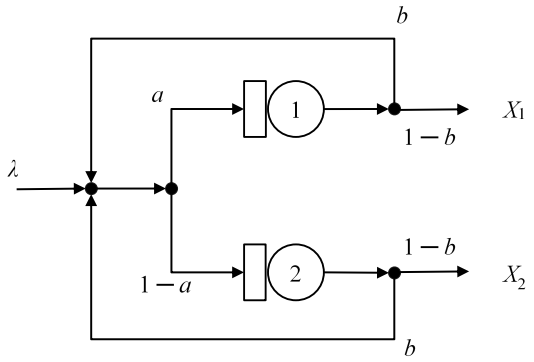
- number of stations K = 1
- service demand Dmax = 1.9 sec
- service demand Dtot = 2.5 sec
- think time Z = 0 sec
- number of users N = 3

Which is the **balanced** lower bound of response time?

A 10.00 sec B 5.70 sec ■ 7.50 sec D 20.34 sec

Explanation:
$\max(D_{tot} + (N-1) * D_{avg}, ND_{max} - Z) = \max(2.5 + (3-1) \times 2.50, 3 \times 1.9) = 7.50$

Question 21 Consider the following open network, where a and b are routing probabilities. Which is the number of visits at station 2?



A $(1-a)*b$ B $1-a$ C $1-a+b$ ■ $(1-a)/(1-b)$

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): 0.9
- Visits station B (Vb): 1.2
- Service time station A (Sa): 0.18 sec/tran
- Service time station B (Sb): 0.33 sec/tran
- Arrival rate (λ): 1.56 tran/sec

Which is the system response time?

A 0.558 sec/tran
B 1.954 sec/tran
C 1.104 sec/tran
■ 1.253 sec/tran