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Computing Infrastructures

Course 095897

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Student ID (codice persona):	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

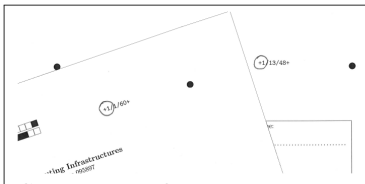
Students must use pen (black or blue) to mark answers (no pencil).
Students are permitted to use a non-programmable calculator.

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).



Check that the first number in the text and in the answer sheet is the same

A **Question 9:** ☐A ☐B ■C ☐D
Question 10: ☐A ☐B ■C ☐D
Question 11: ■A ☐B ☐C ☐D

If you make a mistake:

1. circle the word "Question"
2. write the correct answer to its side

Question 1: ■A ☐B ☐C ☐D
Question 2: ☐A ☐B ■C ☐D
Question 3: ☐A ■B ☐C ☐D
Question 4: ☐A ☐B ☐C ■D

Do not use crosses to mark the answers!
Completely fill the box!

Answer sheet: 10423817

Student ID (codice persona):

☐0	■0	☐0	☐0	☐0	☐0	☐0	☐0
■1	☐1	☐1	☐1	☐1	☐1	■1	☐1
☐2	☐2	☐2	■2	☐2	☐2	☐2	☐2
☐3	☐3	☐3	☐3	■3	☐3	☐3	☐3
☐4	☐4	■4	☐4	☐4	☐4	☐4	☐4
☐5	☐5	☐5	☐5	☐5	☐5	☐5	☐5
☐6	☐6	☐6	☐6	☐6	☐6	☐6	☐6
☐7	☐7	☐7	☐7	☐7	☐7	☐7	■7
☐8	☐8	☐8	☐8	☐8	■8	☐8	☐8
☐9	☐9	☐9	☐9	☐9	☐9	☐9	☐9

Enter the numbers of your "Student ID" from left to right

Question 1 Which statement about Full -Virtualization is correct?

A Hooks are required

■ Requires the hypervision mediation

C Occurs at Operating System-level by means of private Servers

D Cannot be used with traditional Operating Systems

Explanation:

Question 2 In the Microkernel architecture of VMs:

A Drivers are part of the Hypervisor

B Drivers are part of the Guest Oss

■ Drivers are part of a specific service VM

D Drivers are part of the Guest VMs

Explanation:

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

Question 3 Which definition is not encompassed by Dependability:

- [■] Reversibility: ability to reverse a broken service
- [B] Availability: readiness for correct service
- [C] Reliability: continuity of correct service
- [D] Maintainability: reparation to restore correct service

Explanation:
Reversibility is not part of Dependability.

Question 4
Consider a system built by two different components in parallel. Assume for component A: $MTTF_A = 164$ *days* and $MTTR_A = 1$ *days* and for component B: $MTTF_B = 405$ *days* and $MTTR_B = 5$ *days*.
The $MTTF$ computed without repair of the previous system is equal to:

- [A] 66303
- [B] 164
- [■] 452
- [D] 405

Explanation:
$MTTF_{sys} = MTTF_A + MTTF_B - 1/(1/MTTF_A + 1/MTTF_B)$

Question 5 Which of the following statements is correct?

■ Reliability represents the probability of components, parts and systems to perform their required functions for a desired period of time without failure (and repair). Availability represents the probability that the (repairable) system is capable of conducting its required function when it is called upon, given that it is not failed or undergoing a repair action.

B Reliability is a probability, but Availability is not.

C Reliability represents the probability of components, parts and systems to perform their required functions for a desired period of time without failure (and repair). Availability represents the probability that the (repairable) system is capable of conducting its required function when it is called upon, given that it has failed or being repaired.

D Reliability represents the probability of components, parts and systems to perform their required functions for a desired period of time with failure. Availability represents the probability that the (repairable) system is capable of conducting its required function when it is called upon, given that it has not failed.

Explanation:
Reliability represents the probability of components, parts and systems to perform their required functions for a desired period of time without failure (and repair). Availability represents the probability that the (repairable) system is capable of conducting its required function when it is called upon, given that it is not failed or undergoing a repair action.

Question 6 A system is composed by 3 physical machines (Host1, Host2, Host3), with subnet addresses: 192.168.0.1, 192.168.0.2 and 192.168.0.3 (default subnet mask: 255.255.255.0). Two Virtual Machines, VM1 and VM2 run over Host1, connected in bridged mode. Other two Virtual Machines, VM3 and VM4 run over Host2, connected in NAT mode. Finally, the last Virtual Machine, VM5, run over Host3, with internal networking. Assuming that port-forwarding is configured to map port X of the guest on the same port X on the host and that IPs are provided incrementally by the DHCP server on the network:

A VM5 can be reached only by Host3

B a service running inside VM3 and listening on port 22 can be reached at the address: 192.168.0.6:22

■ a service running inside VM2 and listening on port 8080 can be reached at the address: 192.168.0.5:8080

D none of the other answers is valid

Explanation:
Even the host cannot reach a VM with internal networking; VM3 is NATted, so it can only be reached on IP: 192.168.0.2; assuming that IPs are provided incrementally by the DHCP server on the network, VM2 will then have IP: 192.168.0.5, exposing the service running on it.

Question 7 Consider 4 Virtual Machines (VMs) on 3 different Physical Machines (Hosts):

- Host1 @ 192.168.0.1 runs VM1 and VM2, attached to its Bridge adapter;
- Host2 @ 10.0.0.1 run VM3, attached to the NAT adapter;
- Host3 @ 192.168.0.2 runs VM4, connected with host-only networking.

Assuming that the network connecting all the hosts is configured to enable them to see each others (i.e.: Host1 can see Host2):

- [A] a service on VM1 can reach a service on VM4 if port-forwarding is configured
- [■] port-forwarding needs to be configured to expose services running on VM3
- [C] 10.0.0.4 is a possible IP address for VM3
- [D] none of the other answers is valid

Explanation:
No one except Host3 can reach a service on VM4; VM3 is NATted, so a service it hosts on port X can be reached at: 192.168.0.2:X if port forwarding is enabled, while its IP address cannot be on the same subnet: 10.0.0.Y of Host2

Question 8 In memory virtualization:

- [A] the MMU causes a trap if a memory page is already in RAM
- [B] none of the other answers is valid
- [C] the support of the Guest OS is required for memory overcommit
- [■] shadow pages are maintained by the VMM

Explanation:
Lesson_3_Virtualization_B.pdf, multiple slides on memory virtualization

Question 9
Consider a HDD with:

- block size: 3 KB
- mean I/O service time per block (with no locality): 7.3 ms
- transfer time of 1 block: 0.06 ms
- overhead controller: 0.1 ms

How long does it take to transfer a file of 80 MB if we assume a locality of: 50%?

[A] 199.34 s	■ 101.86 s	[C] 104.04 s	[D] none of the others

Explanation:
Total number of blocks to be transferred: 80*1024KB/(3 KB/block) = 27307 blocks
27307*(1-0.50)*7.3ms + 27307*(0.50)*(0.1ms+0.06ms) = 101.86 s

Question 10
Consider 5 groups (RAID 0) of 2 disks each (RAID 1), for a total of 10 disks in configuration RAID 1+0:

- MTTR = 2 days
- MTTF(one disk) = 1400 day

The MTTDL will be:

[A] 537824000000000 days	[B] none of the others	[C] 1344560000000000 days	■ 98000 days

Explanation:
$MTTDL = MTTF^2/(totaldisks * MTTR) = 98000$ days (MTTDL is the same for any couple of disks (data and mirror) of the array)

Question 11 In the selection of a RAID configuration:

- [A] I would consider RAID 6 for its great performance in write-intensive applications
- [B] I would not consider RAID 0 with read-intensive applications, even if high reliability is not mandatory
- [■] I would consider RAID 1 for a database application with high transaction rate
- [D] none of the other answers is valid

Explanation:
RAID 1 is a good choice for a database application (i.e., reliability is important) with high transaction rate, as it's write performance is good; RAID 6 has pretty poor writing performance, while RAID 0 is a good choice for high-perf computing (i.e., it provides very good read and write performance), if reliability is not mandatory

Question 12
Consider the following measurement data for an interactive system

- measurement interval: 5 minutes
- number of users: 53
- number of servers: 24
- average response time per transaction: 20 seconds
- Dmax 1.4 sec/transaction
- Dtot 1.7 sec/transaction
- number of completed transactions: 70

On average, how many users are thinking?

[A] 4.67 [B] 25.00 [C] 30.57 [■] 48.33

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

Question 13
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: 0.62
- CPU demand: 0.43 seconds/transaction
- Number of I/O operations / transaction 11
- Response time: 18 seconds/transaction
- Number of users: 42

Which is the average think time of these users?

[A] 9.64 sec [■] 11.13 sec [C] 29.13 sec [D] 6.66 sec

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

Question 14
Consider a closed system with the following data: average number of users: 19 ($N = 19$) average response time: 42 sec ($R = 42$), average throughput: 0.53 trans/sec ($X = 0.53$), average CPU service demand: 0.79 sec/trans ($D_{\mathrm{CPU}} = 0.79$). Which is the CPU utilization?

[A] 0.58 [B] 0.03 [C] 0.65 [■] 0.42

Explanation:
Ucpu = X*Dcpu

Question 15
By monitoring a single class iteractive system, we are able to measure the following data:

- Monitoring period: 90 seconds
- CPU service time: 0.38 seconds/operation
- CPU utilization: 0.59
- Disk throughput: 7 operations/second
- Disk visits: 10 operations/transaction
- Response time: 0.8 seconds/transaction
- Number of users: 27

Which is the average think time of these users?

■ 37.77 sec B 89.20 sec C 3.06 sec D 38.57 sec

Explanation:
X = Xdisk / Vdisk = 0.700000000000000000
Z = N/X - R = 37.77

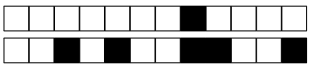
Question 16
Consider a single-class multi station system with two stations. We have the following information about the system:

- station 1 response time: 10 seconds
- station 2 response time: 4 seconds
- station 1 throughput: 3 transactions/second
- station 2 throughput: 6 transactions/second
- system throughput: 3 transactions/second

Which is the average response time of the system?

A 14.00 sec B 1.00 sec C 14.87 sec ■ 18.00 sec

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



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

- service demand Dmax = 0.5 sec
- service demand Dtot = 3.5 sec
- think time Z = 3 sec
- number of users N = 4

Which is the asymptotic upper bound of throughput?

A 1.14 tran/sec ■ 0.62 tran/sec C 2.00 tran/sec D 8.00 tran/sec

Explanation:
$\min(\frac{N}{D+Z}, \frac{1}{D_{max}}) = \min(\frac{4}{3.5+3}, \frac{1}{0.5}) = 0.62$

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

- service demand Dmax = 1.2 sec
- service demand Dtot = 1.7 sec
- think time Z = 1.1 sec
- number of users N = 3

Which is the asymptotic upper bound of response time?

A 3.91 sec B 4.49 sec ■ 5.10 sec D 2.50 sec

Explanation:
$ND = 3 \times 1.7 = 5.10$

Question 19
Consider a batch system with one CPU and two disks, for which the following measurements have been obtained:

- Monitoring period: 400 seconds
- CPU busy time: 125 seconds
- Slow disk busy time: 70 seconds
- Fast disk busy time: 220 seconds
- Completed transactions: 100
- CPU completed operations: 100
- Slow disk completed operations: 100
- Fast disk completed operations: 500
- Number of concurrent jobs: 1

Using only the information available, shift files between disks in order to balance load between the two disks and increase the expected maximum throughput. Using asymptotic bounds, which is the maximum throughput for the **new, improved system** after you have moved the files? *Visits are not required to be integer number.*

A 0.61350 ■ 0.22261 C 0.24096 D 0.61688

Explanation:
$D_{slow} = B_{slow}/C = 0.7$ $D_{fast} = B_{fast}/C = 2.2$
$V_{fast} = C_{fast}/C = 5$ $V_{slow} = C_{slow}/C = 1$ $V_{bal} = V_{fast} + V_{slow} = 6$
$S_{fast} = D_{fast}/V_{fast} = 0.440000000000000000$ $S_{slow} = D_{slow}/V_{slow} = 0.700000000000000000$
$D_{cpu} = B_{cpu}/C = 1.25$ $D_{bal} = V_{bal}/(1/S_{slow} + 1/S_{fast}) = 1.450000000000000000$ $D_{totb} = 2 * D_{bal} + D_{cpu} = 4.150000000000000000$ $D_{maxb} = \max(D_{bal}, D_{cpu}) = 1.450000000000000000$
$X_{maxb} = \min(1/D_{maxb}, N/D_{totb}) = 0.22261$

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

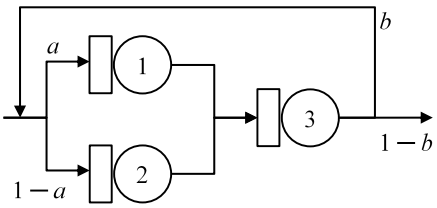
- number of stations K = 2
- service demand Dmax = 2.1 sec
- service demand Dtot = 3.2 sec
- think time Z = 0 sec
- number of users N = 5

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

A 9.60 sec B 28.90 sec ■ 10.50 sec D 11.20 sec

Explanation:
$\max(D_{tot} + (N-1) * D_{avg}, ND_{max} - Z) = \max(3.2 + (5-1) \times 1.60, 5 \times 2.1) = 10.50$

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



■ $a/(1-b)$ B $(1-a)/(1-b)$ C $1/(1-b)$ D $1+a+ab$

Explanation:
V1 = a*(1 + b*V3)
V2 = (1 - a)*(1 + b*V3)
V3 = V1 + V2 = 1 + b*V3
V3 = 1/(1 - b)
V1 = a/(1 - b)
V2 = (1 - a)/(1 - b)

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

- Visits station A (Va): 0.9
- Visits station B (Vb): 1.1
- Service time station A (Sa): 0.35 sec/tran
- Service time station B (Sb): 0.14 sec/tran
- Arrival rate (λ): 1.67 tran/sec

Which is the system response time?

A 0.927 sec/tran
B 0.469 sec/tran
■ 0.872 sec/tran
D 1.456 sec/tran