+17/1/19+

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

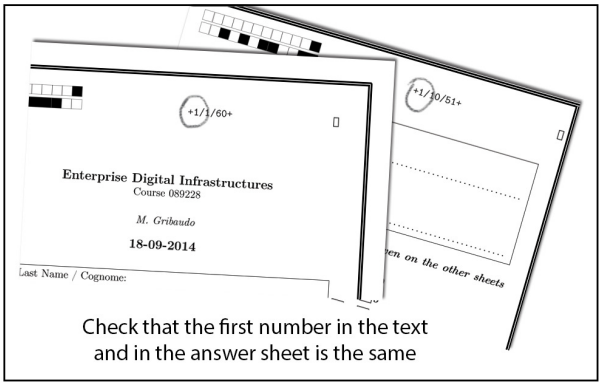
Students must use pen (black or blue) to mark answers (no pencil).
Students are permitted to use a non-programmable calculator.

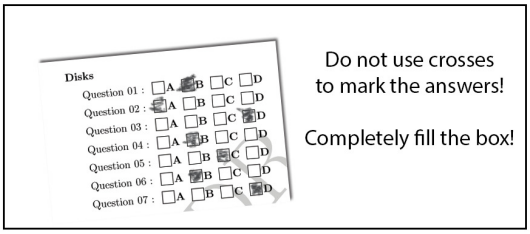
Students are NOT permitted to copy anyone else's answers, pass notes amongst themselves, or engage in other forms of misconduct at any time during the exam.

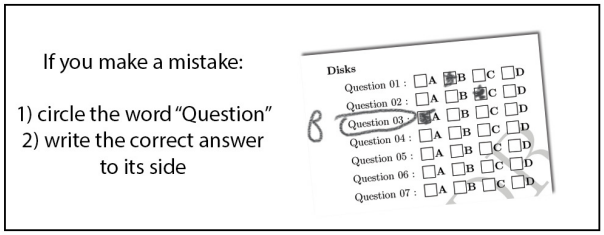
Students are NOT permitted to use mobile phones and similar connected devices.

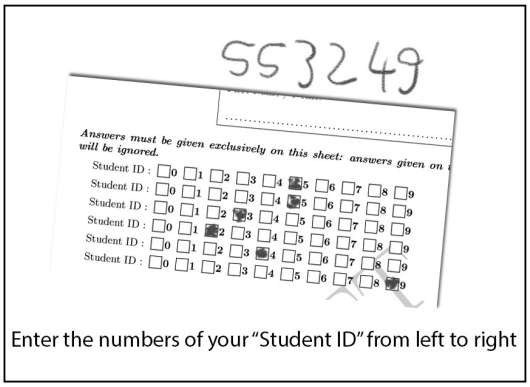
Scores: correct answers +1.5 point, unanswered questions 0 points, wrong answers -0.5 points.

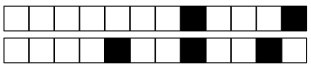
Questions with multiple answers will be considered as not answered (0 points).











Question 1 Gmail is an example of

- [A] Infrastructure as a service
- [■] Software as a Service
- [C] Platform as a Service
- [D] Communication as a service

Explanation:

Question 2 Which statement about Paravirtualization is correct?

- [■] Cannot be used with traditional Operating Systems
- [B] Is the same of Kernel-level Virtualization
- [C] Hooks are not required
- [D] Occurs at Operating System-level by means of private Servers

Explanation:

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

Question 3
Consider a generic component D with $MTTF_D = 800$. Compute the minimum integer value of t such that the failure probability of the component is greater than 0.6.

A 733 B 480 C 656 ■ 734

Explanation:
$1 - e^{-t/800} \geq 0.6$
$(1 - 0.6) \geq e^{-t/800}$
$\ln(1 - 0.6) \geq -t/800$
$t \geq -800 \ln(1 - 0.6)$
$t \geq 733.0326$

Question 4
Consider two components A and B in a serial configuration. They have the following characteristics: $MTTF_A = 500\ days$, $MTTR_A = 2\ days$; $MTTF_B = 100\ days$, $MTTR_B = 3\ days$.
It is required to change component B in order to achieve a system MTTF, computed without repair, equal to $MTTF_{Sys} = 132$. The required upgrade is:

■ $MTTF_B = 179$ B $MTTF_B = 250$ C $MTTF_B = 140$ D Impossible

Explanation:
$MTTF_{Sys} = 132 = \frac{1}{\frac{1}{MTTF_A} + \frac{1}{MTTF_B}} = \frac{MTTF_A MTTF_B}{MTTF_A + MTTF_B}$

$MTTF_B = \frac{MTTF_A MTTF_{Sys}}{MTTF_A - MTTF_{Sys}} = \frac{500 \times 132}{500 - 132} = 179$

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

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

Explanation:
You must use elements with high MTTF

Question 6 The Nested Pages mechanism:

- [A] does not require special hardware to support it
- [B] is completely managed by the VMM software
- [■] is supported by the Translation Lookaside Buffer (TLB)
- [D] implies more software-level overhead than the Shadow Pages mechanism

Explanation:
Lesson_3_Virtualization_B.pdf, slide 31

Question 7 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] none of the other answers is valid
- [■] a service running inside VM2 and listening on port 8080 can be reached at the address: 192.168.0.5:8080
- [D] a service running inside VM3 and listening on port 22 can be reached at the address: 192.168.0.6:22

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 8 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] 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
- [C] 192.168.0.3 is a possible IP address for VM1 on the hosts' subnet
- [D] a service running inside VM3 and listening on port 22 can be reached at the address: 192.168.0.2:22

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 9
Consider a HDD with:

- block size: 1 KB
- mean I/O service time per block (with no locality): 14.0 ms
- transfer time of 1 block: 0.02 ms
- overhead controller: 0.1 ms

How long does it take to transfer a file of 120 MB if we assume a locality of: 40%?

- [A] 1046.94 s
- [B] none of the others
- [C] 1720.32 s
- [■] 1038.09 s

Explanation:
Total number of blocks to be transferred: 120*1024KB/(1 KB/block) = 122880 blocks
122880*(1-0.40)*14.0ms + 122880*(0.40)*(0.1ms+0.02ms) = 1038.09 s

Question 10
Consider the following RAID 0 setup:

- n = 4 disks
- MTTR = 9 hours
- MTTF(one disk) = 1900 day

The MTTDL will be:

A 211 hours | B 211 days | C none of the others | ■ 475 days

Explanation:
MTTDL = MTTF(1 disk) / n = 475 days (as MTTDL does not depend on MTTR)

Question 11 In the selection of a RAID configuration:

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

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

- Monitoring period: 70 seconds
- CPU service time: 0.31 seconds/operation
- CPU utilization: 0.53
- Disk throughput: 8 operations/second
- Disk visits: 12 operations/transaction
- Response time: 0.8 seconds/transaction
- Number of users: 42

Which is the average think time of these users?

A 63.00 sec ■ 62.20 sec C 4.45 sec D 69.20 sec

Explanation:
X = Xdisk / Vdisk = 0.666666666666666666
Z = N/X - R = 62.20

Question 13
Consider a closed system with the following data: average number of users: 17 ($N = 17$) average response time: 38 sec ($R = 38$), average throughput: 0.45 trans/sec ($X = 0.45$), average CPU service demand: 0.76 sec/trans ($D_{\mathrm{CPU}} = 0.76$). Which is the CPU utilization?

A 0.66 B 0.03 C 0.65 ■ 0.34

Explanation:
Ucpu = X*Dcpu

Question 14
Consider a closed system with the following data: average number of users: 21 ($N = 21$) average response time: 29 sec ($R = 29$), average throughput: 0.40 trans/sec ($X = 0.40$), average CPU service demand: 0.68 sec/trans ($D_{\mathrm{CPU}} = 0.68$). Which is the average think time Z of a user?

A 30.88 sec ■ 23.50 sec C 1.88 sec D 52.50 sec

Explanation:
Z = N/X - R

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

- station 1 response time: 8 seconds
- station 2 response time: 5 seconds
- station 1 throughput: 3 transactions/second
- station 2 throughput: 6 transactions/second
- system throughput: 4 transactions/second

Which is the average response time of the system?

A 7.94 sec B 0.56 sec ■ 13.50 sec D 13.00 sec

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

Question 16
Consider the following measurement data for an interactive system

- measurement interval: 5 minutes
- number of users: 45
- number of servers: 17
- average response time per transaction: 18 seconds
- Dmax 1.0 sec/transaction
- Dtot 1.9 sec/transaction
- number of completed transactions: 78

On average, how many users are thinking?

A 16.92 B 23.71 C 4.68 ■ 40.32

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

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

- service demand Dmax = 2.2 sec
- service demand Dtot = 4.2 sec
- think time Z = 2 sec
- number of users N = 3

Which is the asymptotic lower bound of response time?

A 3.21 sec B 2.68 sec C 3.68 sec ■ 4.60 sec

Explanation:
$\max(D, ND_{max} - Z) = \max(4.2, 3 \times 2.2 - 2) = 4.60$

Question 18
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: 200 seconds
- Slow disk busy time: 144 seconds
- Fast disk busy time: 304 seconds
- Completed transactions: 200
- 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 0.77973 B 0.42277 C 0.30864 ■ 0.28050

Explanation:
Dcpu: 1 Dslow: 0.72 Dfast: 1.52
Scpu: 2.000000000000000000 Sslow: 1.440000000000000000 Sfast: 0.608000000000000000
Vcpu: 0.5 Vslow: 0.5 Vfast: 2.5 Vslowb: 0.777777777777777777 Vfastb: 1.842105263157894736
Dbal: 1.120000000000000000 Dtotb: 3.240000000000000000 Dmaxb: 1.120000000000000000
SOLUTION: 0.28050

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

- service demand Dmax = 0.9 sec
- service demand Dtot = 1.5 sec
- think time Z = 0.7 sec
- number of users N = 5

Which is the asymptotic upper bound of response time?

A 5.23 sec ■ 7.50 sec C 4.04 sec D 3.80 sec

Explanation:
$ND = 5 \times 1.5 = 7.50$

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

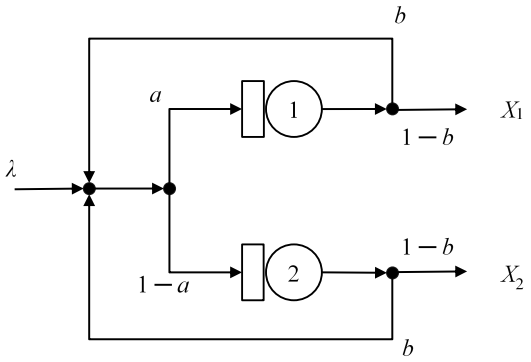
- number of stations K = 4
- service demand Dmax = 1.2 sec
- service demand Dtot = 2.0 sec
- think time Z = 0 sec
- number of users N = 4

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

A 3.50 sec ■ 4.80 sec C 11.87 sec D 4.00 sec

Explanation:
$\max(D_{tot} + (N-1) * D_{avg}, ND_{max} - Z) = \max(2.0 + (4-1) \times 0.50, 4 \times 1.2) = 4.80$

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 $a*b$ C a D $a+b$

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): 1.2
- Visits station B (Vb): 1.4
- Service time station A (Sa): 0.37 sec/tran
- Service time station B (Sb): 0.39 sec/tran
- Arrival rate (λ): 1.34 tran/sec

Which is the system response time?

A 0.990 sec/tran
■ 3.131 sec/tran
C 4.195 sec/tran
D 2.367 sec/tran