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Computing Infrastructures

Course 095897

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21-01-2019

Student ID (codice persona):	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

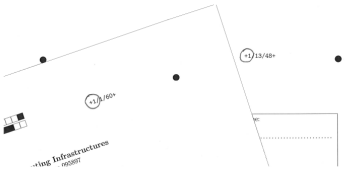
Students must use pen (black or blue) to mark answers (no pencil).
Students are permitted to use a non-programmable calculator.

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 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

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!

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

Answer sheet: 104238 17

Student ID (codice persona):

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

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

Question 1 Which statement about Paravirtualization is correct?

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

Explanation:

Question 2 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:

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: $MTTF_{Pr} = 500\ days$, $MTTR_{Pr} = 2\ days$. The parameters of the hard disk are: $MTTF_{HD} = 800\ days$, $MTTR_{HD} = 1\ days$. Which is the minimum number of processors in parallel required to achieve a reliability at $t = 111$ greater than 0.835 ?

A 4 | B It is not possible | C 1 | ■ 2

Explanation:
$R_{pr}(111) = e^{-111/500} = 0.8009$
$R_{hd}(111) = e^{-111/800} = 0.8704$
With 2 processors: $R_{sys} = (1 - (1 - 0.8009)^2) * 0.8704 = 0.8359 \geq 0.835$

Question 4
Consider a system built by two different components in parallel. Assume for component A: $MTTF_A = 121\ days$ and $MTTR_A = 9\ days$ and for component B: $MTTF_B = 238\ days$ and $MTTR_B = 11\ days$. The availability of the whole system is equal to:

■ 0.996941 | B None of the others | C 0.943295 | D 0.889648

Explanation:
$A_A = MTTF_A/(MTTF_A + MTTR_A) = 0.93077$
$A_B = MTTF_B/(MTTF_B + MTTR_B) = 0.95582$
$A_{sys} = 1 - (1 - A_A) * (1 - A_B) = 0.996941$

Question 5
A control system consists of 2 sensors, an input-output module and a controller. All devices are repairable. The component-module per type availabilities A_i are: Sensor 0.7, Input-Output Module 0.6 and Controller 0.6. Assume that when a component or a module fails, the system fails. What is the system availability A_S?

[A] 0.2520 [B] 0.0757 [■] 0.1764 [D] 0.0678

Explanation:
$A_S = 0.7 * 0.7 * 0.6 * 0.6 = 0.1764$

Question 6 In memory virtualization, "ballooning" is a technique that:

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

Explanation:
Lesson_3_Virtualization_B.pdf, slide 18

Question 7 With Bridged Networking:

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

Explanation:
Lesson_3_Virtualization_B.pdf, slide 56

Question 8 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 none of the other answers is valid

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

C 10.0.0.4 is a possible IP address for VM3

■ port-forwarding needs to be configured to expose services running on VM3

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 9
Consider a HDD with:

- data transfer rate: 230 MB/s
- rotation speed: 12000 RPM
- mean seek time: 9 ms
- overhead controller: 0.2 ms

The mean I/O service time to transfer a sector of 9 KB will be:

A 11.41 ms B 4.39 ms ■ 11.74 ms D 2.53 ms

Explanation:
Mean latency: (1/2 round) * (60s/min) * 1/(12000 round/min) = 2.499 ms
Transfer time: (9 KB) / (230 * 1024 KB/s) = 0.038ms
Mean I/O service time = 9 + 0.2 + 2.499 + 0.038 = 11.74

Question 10 In the selection of a RAID configuration:

- [■] I would consider RAID 1 for a database application with high transaction rate
- [B] I would consider RAID 6 for its great performance in write-intensive applications
- [C] none of the other answers is valid
- [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 11
Consider the following RAID 5 setup:

- n = 4 disks
- MTTR = 2 days
- MTTF(one disk) = 1900 day

The MTTDL will be:

[A] 112812 days [B] 79 days [■] 150417 days [D] none of the others

Explanation:
$MTTDL = MTTF^2/(n * (n-1) * MTTR) = 150417 days$

Question 12
Consider a closed system with the following data: average number of users: 23 ($N = 23$) average response time: 30 sec ($R = 30$), 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 56.10 sec B 5.38 sec C 35.38 sec ■ 26.10 sec

Explanation:
Z = N/X - R

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

- Monitoring period: 80 seconds
- CPU service time: 0.33 seconds/operation
- CPU utilization: 0.57
- Disk throughput: 10 operations/second
- Disk visits: 17 operations/transaction
- Response time: 0.3 seconds/transaction
- Number of users: 30

Which is the average think time of these users?

A 51.00 sec ■ 50.70 sec C 2.70 sec D 79.70 sec

Explanation:
X = Xdisk / Vdisk = 0.588235294117647058
Z = N/X - R = 50.70

Question 14
Consider a closed system with the following data: average number of users: 21 ($N = 21$) average response time: 40 sec ($R = 40$), average throughput: 0.45 trans/sec ($X = 0.45$), average CPU service demand: 0.77 sec/trans ($D_{\text{CPU}} = 0.77$). Which is the CPU utilization?

A 0.65 B 0.69 ■ 0.35 D 0.02

Explanation:
Ucpu = X*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: 8 seconds
- station 2 response time: 2 seconds
- station 1 throughput: 4 transactions/second
- station 2 throughput: 6 transactions/second
- system throughput: 4 transactions/second

Which is the average response time of the system?

■ 11.00 sec B 10.00 sec C 8.86 sec D 0.63 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: 51
- number of servers: 24
- average response time per transaction: 21 seconds
- Dmax 2.2 sec/transaction
- Dtot 2.7 sec/transaction
- number of completed transactions: 77

On average, how many users are thinking?

[A] 5.39 [redacted] 45.61 [C] 37.67 [D] 18.66

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 = 0.9 sec
- service demand Dtot = 2.8 sec
- think time Z = 2 sec
- number of users N = 3

Which is the asymptotic upper bound of throughput?

[A] 1.07 tran/sec [B] 3.33 tran/sec [C] 1.11 tran/sec [redacted] 0.63 tran/sec

Explanation:
$\min(\frac{N}{D+Z}, \frac{1}{D_{max}}) = \min(\frac{3}{2.8+2}, \frac{1}{0.9}) = 0.63$

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

- service demand Dmax = 0.6 sec
- service demand Dtot = 1.9 sec
- think time Z = 2 sec
- number of users N = 4

Which is the asymptotic lower bound of response time?

A 1.25 sec ■ 1.90 sec C 1.39 sec D 1.24 sec

Explanation:
$\max(D, ND_{max} - Z) = \max(1.9, 4 \times 0.6 - 2) = 1.90$

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

- service demand Dmax = 1.9 sec
- service demand Dtot = 3.0 sec
- think time Z = 1 sec
- number of users N = 4

Which is the asymptotic lower bound of throughput?

A 0.33 tran/sec ■ 0.31 tran/sec C 0.23 tran/sec D 0.53 tran/sec

Explanation:
$\frac{N}{ND+Z} = \frac{4}{4 \times 3.0 + 1} = 0.31$

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

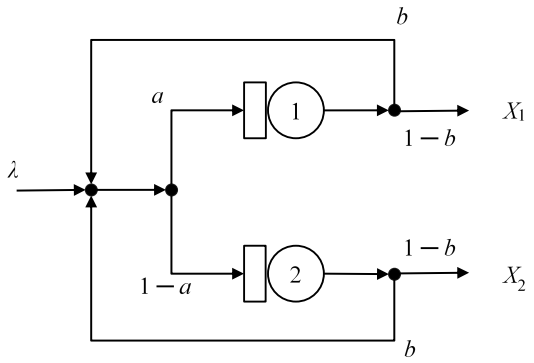
- number of stations K = 3
- service demand Dmax = 1.7 sec
- service demand Dtot = 3.5 sec
- think time Z = 0 sec
- number of users N = 4

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

■ 7.00 sec B 8.17 sec C 6.80 sec D 18.67 sec

Explanation:
$\max(D_{tot} + (N-1) * D_{avg}, ND_{max} - Z) = \max(3.5 + (4-1) \times 1.17, 4 \times 1.7) = 7.00$

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



A $a + b$ B $a * b$ ■ $a/(1-b)$ 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): 0.6
- Visits station B (Vb): 1.4
- Service time station A (Sa): 0.64 sec/tran
- Service time station B (Sb): 0.07 sec/tran
- Arrival rate (λ): 1.73 tran/sec

Which is the system response time?

■ 1.262 sec/tran
B 2.183 sec/tran
C 0.482 sec/tran
D 1.991 sec/tran