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Computing Infrastructures

Course 095897

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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

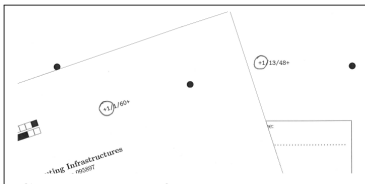
Students must use pen (black or blue) to mark answers (no pencil).
Students are permitted to use a non-programmable calculator.

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

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: 104238 12

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 Paravirtualization is correct?

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

Explanation:

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

- [A] PaaS accelerates the deployment
- [B] PaaS supports the scalability
- [■] Gmail is an example of PaaS
- [D] PaaS provides developers with a programming-language-level environment and API

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: $MTTF_{Pr} = 400\ days$, $MTTR_{Pr} = 6\ days$. The parameters of the hard disk are: $MTTF_{HD} = 600\ days$, $MTTR_{HD} = 3\ days$. The reliability of the system at $t = 112\ days$ is equal to:

A 0.7558	B 0.1832	■ 0.7802	D 0.8297

Explanation:
$R_{pr}(112) = e^{-112/400} = 0.7558$
$R_{hd}(112) = e^{-112/600} = 0.8297$
$R_{sys} = (1 - (1 - 0.7558)^2) * 0.8297 = 0.7802$

Question 4
Consider two components A and B in a serial configuration. They have the following characteristics: $MTTF_A = 500\ days$, $MTTR_A = 5\ days$; $MTTF_B = 300\ days$, $MTTR_B = 1\ days$.
The reliability of the system at $t = 50\ days$ is equal to:

■ 0.7659	B 0.8204	C 0.8465	D 0.7822

Explanation:
$R_A(50) = e^{-50/500} = 0.9048$
$R_B(50) = e^{-50/300} = 0.8465$
$R_{sys} = R_A * R_B = 0.7659$

Question 5 The following sentence: "The probability that the component does not fail in the interval 0 ... t, knowing that at the instant t = 0 the component was working correctly" defines:

A Availability	B None of these answers is correct	C Performance	■ Reliability

Explanation:
The correct answer is reliability.

Question 6 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

B none of the other answers is valid

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

D 10.0.0.4 is a possible IP address for 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 7 The Nested Pages mechanism:

■ is supported by the Translation Lookaside Buffer (TLB)

B does not require special hardware to support it

C implies more software-level overhead than the Shadow Pages mechanism

D is completely managed by the VMM software

Explanation:
Lesson_3_Virtualization_B.pdf, slide 31

Question 8 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 service running inside VM2 and listening on port 8080 can be reached at the address: 192.168.0.5:8080

B none of the other answers is valid

C VM5 can be reached only by Host3

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 9
Consider a HDD with:

- data transfer rate: 290 MB/s
- rotation speed: 11000 RPM
- mean seek time: 20 ms
- overhead controller: 0.9 ms

The mean I/O service time to transfer a sector of 4 KB will be:

A 6.40 ms B 2.74 ms ■ 23.64 ms D 22.06 ms

Explanation:
Mean latency: (1/2 round) * (60s/min) * 1/(11000 round/min) = 2.727 ms
Transfer time: (4 KB) / (290 * 1024 KB/s) = 0.013ms
Mean I/O service time = 20 + 0.9 + 2.727 + 0.013 = 23.64

Question 10
Consider the following RAID 1 setup:

- n = 2 disks
- MTTR = 7 days
- MTTF(one disk) = 1800 day

The MTTDL will be:

■ 231429 days | B none of the others | C 900 days | D 33061 days

Explanation:
$MTTDL = \frac{MTTF^2}{n*MTTR} = 231429$ days

Question 11
Consider the following RAID 6 setup:

- n = 5 disks
- MTTR = 2 days
- MTTF(one disk) = 1100 day

The MTTDL will be:

A 20167 days | B 55458333 days | C none of the others | ■ 11091667 days

Explanation:
$MTTDL = 2 * MTTF^3/(n * (n-1) * (n-2) * MTTR^2) = 11091667 days$

Question 12
Consider the following measurement data for an interactive system

- measurement interval: 5 minutes
- number of users: 47
- number of servers: 17
- average response time per transaction: 19 seconds
- Dmax 1.7 sec/transaction
- Dtot 1.9 sec/transaction
- number of completed transactions: 73

On average, how many users are thinking?

[A] 31.59 [B] 19.26 [C] 4.62 [■] 42.38

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: 120 seconds
- CPU service time: 0.30 seconds/operation
- CPU utilization: 0.52
- Disk throughput: 9 operations/second
- Disk visits: 12 operations/transaction
- Response time: 0.2 seconds/transaction
- Number of users: 11

Which is the average think time of these users?

A 1.02 sec B 14.67 sec C 119.80 sec ■ 14.47 sec

Explanation:
X = Xdisk / Vdisk = 0.750000000000000000
Z = N/X - R = 14.47

Question 14
Consider a closed system with the following data: average number of users: 23 ($N = 23$) average response time: 27 sec ($R = 27$), average throughput: 0.49 trans/sec ($X = 0.49$), average CPU service demand: 0.69 sec/trans ($D_{\mathrm{CPU}} = 0.69$). Which is the average think time Z of a user?

■ 19.94 sec B 6.33 sec C 33.33 sec D 46.94 sec

Explanation:
Z = N/X - R

Question 15
Consider a closed system with the following data: average number of users: 20 ($N = 20$) average response time: 40 sec ($R = 40$), average throughput: 0.50 trans/sec ($X = 0.50$), average CPU service demand: 0.77 sec/trans ($D_{\text{CPU}} = 0.77$). Which is the CPU utilization?

■ 0.39 B 0.74 C 0.61 D 0.03

Explanation:
Ucpu = X*Dcpu

Question 16
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: 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 13.00 sec B 15.20 sec ■ 18.00 sec D 1.11 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 = 0.7 sec
- service demand Dtot = 0.8 sec
- think time Z = 1 sec
- number of users N = 5

Which is the asymptotic lower bound of throughput?

A 0.80 tran/sec ■ 1.00 tran/sec C 1.43 tran/sec D 1.25 tran/sec

Explanation:
$\frac{N}{ND+Z} = \frac{5}{5\times 0.8+1} = 1.00$

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

- service demand Dmax = 1.8 sec
- service demand Dtot = 3.1 sec
- think time Z = 2 sec
- number of users N = 3

Which is the asymptotic lower bound of response time?

A 2.28 sec B 2.36 sec ■ 3.40 sec D 1.82 sec

Explanation:
$\max(D, ND_{max} - Z) = \max(3.1, 3 \times 1.8 - 2) = 3.40$

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

- service demand Dmax = 0.6 sec
- service demand Dtot = 4.2 sec
- think time Z = 2 sec
- number of users N = 5

Which is the asymptotic upper bound of throughput?

A 1.67 tran/sec B 8.33 tran/sec ■ 0.81 tran/sec D 1.19 tran/sec

Explanation:
$\min(\frac{N}{D+Z}, \frac{1}{D_{max}}) = \min(\frac{5}{4.2+2}, \frac{1}{0.6}) = 0.81$

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

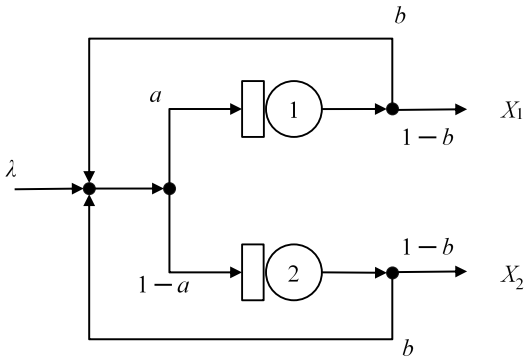
- number of stations K = 5
- service demand Dmax = 0.7 sec
- service demand Dtot = 2.2 sec
- think time Z = 0 sec
- number of users N = 5

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

■ 3.96 sec B 9.07 sec C 3.50 sec D 4.40 sec

Explanation:
$\max(D_{tot} + (N-1) * D_{avg}, ND_{max} - Z) = \max(2.2 + (5-1) \times 0.44, 5 \times 0.7) = 3.96$

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): 0.9
- Visits station B (Vb): 1.1
- Service time station A (Sa): 0.43 sec/tran
- Service time station B (Sb): 0.07 sec/tran
- Arrival rate (λ): 1.75 tran/sec

Which is the system response time?

A 2.254 sec/tran
B 0.464 sec/tran
C 1.413 sec/tran
■ 1.288 sec/tran