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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

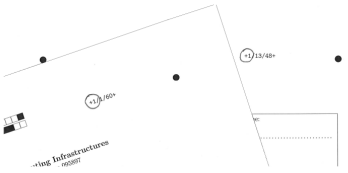
Students must use pen (black or blue) to mark answers (no pencil).
Students are permitted to use a non-programmable calculator.

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 Gmail is an example of

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

Explanation:

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

- [■] Gmail is an example of PaaS
- [B] PaaS accelerates the deployment
- [C] PaaS supports the scalability
- [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 system is composed of two identical devices *d*. If $MTTF_d = 400000$, which is the probability that at least one of them fails?

■ 0.1231 B 0.8769 C 0.9364 D 0.0636

Explanation:
$P(X \leq t) = 1 - e^{-hours/MTTFd*2}$

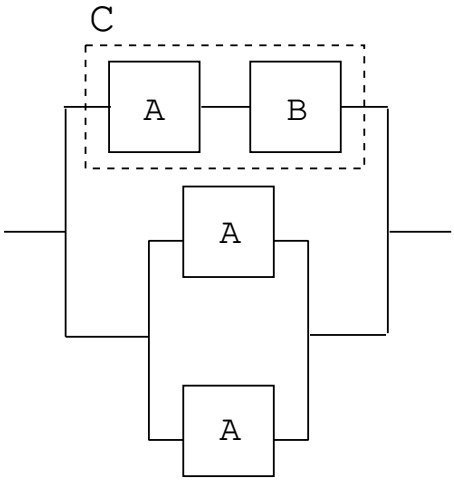
Question 4
Let us now consider a generic component D. Compute the minimum integer value of $MTTF_D$ in order to have at $t = 10$ *days* a reliability $R_D(t) \geq 0.93$.

■ 138 B 55 C 127 D 10

Explanation:
$R_D(t) \geq 0.93 \quad e^{-t/MTTF_D} \geq 0.93 \quad -t/MTTF_D \geq ln(0.93)$
$MTTF_D \geq -t/ln(0.93)$

Question 5

Consider now the components A and B organized as in figure below. Assume for component A: $MTTF_A = 161$ *days* and $MTTR_A = 1$ *days* and for component B: $MTTF_B = 497$ *days* and $MTTR_B = 5$ *days*.



The MTTF without repair of block C is equal to:

A 42.90898	B 161.09415	■ 121.60638	D 329.00000

Explanation:

$MTTF_C = 1/(1/MTTF_A + 1/MTTF_B)$

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 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

C VM5 can be reached only by Host3

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

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

D none of the other answers is valid

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:

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

Explanation:
Lesson_3_Virtualization_B.pdf, multiple slides on memory virtualization

Question 9
Consider a HDD with:

- data transfer rate: 270 MB/s
- rotation speed: 10000 RPM
- mean seek time: 13 ms
- overhead controller: 0.7 ms

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

[A] 3.01 ms [B] 6.03 ms [C] 16.04 ms [■] 16.71 ms

Explanation:
Mean latency: (1/2 round) * (60s/min) * 1/(10000 round/min) = 3.000 ms
Transfer time: (4 KB) / (270 * 1024 KB/s) = 0.014ms
Mean I/O service time = 13 + 0.7 + 3.000 + 0.014 = 16.71

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 1 setup:

- n = 2 disks
- MTTR = 8 days
- MTTF(one disk) = 2000 day

The MTTDL will be:

[A] 1000 days [B] none of the others [■] 250000 days [D] 31250 days

Explanation:
$MTTDL = \frac{MTTF^2}{n*MTTR} = 250000$ days

Question 12
Consider the following measurement data for an interactive system

- measurement interval: 5 minutes
- number of users: 52
- number of servers: 17
- average response time per transaction: 17 seconds
- Dmax 0.6 sec/transaction
- Dtot 0.7 sec/transaction
- number of completed transactions: 78

On average, how many users are thinking?

A 37.57 B 4.42 C 25.48 ■ 47.58

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

Question 13
Consider a single-class multi station system with two stations. We have the following information about the system:

- station 1 response time: 9 seconds
- station 2 response time: 2 seconds
- station 1 throughput: 4 transactions/second
- station 2 throughput: 5 transactions/second
- system throughput: 3 transactions/second

Which is the average response time of the system?

A 12.69 sec B 11.00 sec C 1.00 sec ■ 15.33 sec

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

Question 14
Consider a closed system with the following data: average number of users: 24 ($N = 24$) average response time: 31 sec ($R = 31$), average throughput: 0.44 trans/sec ($X = 0.44$), average CPU service demand: 0.61 sec/trans ($D_{\mathrm{CPU}} = 0.61$). Which is the average think time Z of a user?

A 54.55 sec ■ 23.55 sec C 8.34 sec D 39.34 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: 38 sec ($R = 38$), average throughput: 0.48 trans/sec ($X = 0.48$), average CPU service demand: 0.84 sec/trans ($D_{\mathrm{CPU}} = 0.84$). Which is the CPU utilization?

■ 0.40 B 0.60 C 0.02 D 0.78

Explanation:
Ucpu = X*Dcpu

Question 16
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: 0.56
- CPU demand: 0.37 seconds/transaction
- Number of I/O operations / transaction 9
- Response time: 21 seconds/transaction
- Number of users: 44

Which is the average think time of these users?

[A] 4.62 sec [■] 8.07 sec [C] 6.77 sec [D] 29.07 sec

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

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

- service demand Dmax = 1.8 sec
- service demand Dtot = 10.3 sec
- think time Z = 2 sec
- number of users N = 5

Which is the asymptotic upper bound of throughput?

[A] 2.78 tran/sec [B] 0.49 tran/sec [■] 0.41 tran/sec [D] 0.56 tran/sec

Explanation:
$\min(\frac{N}{D+Z}, \frac{1}{D_{max}}) = \min(\frac{5}{10.3+2}, \frac{1}{1.8}) = 0.41$

Question 18
Consider a batch system with one CPU and two disks, for which the following measurements have been obtained:

- Monitoring period: 250 seconds
- CPU busy time: 72 seconds
- Slow disk busy time: 40 seconds
- Fast disk busy time: 175 seconds
- Completed transactions: 100
- CPU completed operations: 100
- Slow disk completed operations: 100
- Fast disk completed operations: 1000
- Number of concurrent jobs: 2

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 0.69686 ■ 0.58854 C 0.74675 D 1.38889

Explanation:
Dcpu: 0.72 Dslow: 0.4 Dfast: 1.75
Scpu: 0.720000000000000000 Sslow: 0.400000000000000000 Sfast: 0.175000000000000000
Vcpu: 1 Vslow: 1 Vfast: 10 Vslowb: 2.687500000000000000 Vfastb: 6.142857142857142857
Dbal: 1.075000000000000000 Dtotb: 2.870000000000000000 Dmaxb: 1.075000000000000000
SOLUTION: 0.58854

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

- service demand Dmax = 1.6 sec
- service demand Dtot = 1.8 sec
- think time Z = 2 sec
- number of users N = 5

Which is the asymptotic lower bound of throughput?

A 0.63 tran/sec ■ 0.45 tran/sec C 0.36 tran/sec D 0.56 tran/sec

Explanation:
$\frac{N}{ND+Z} = \frac{5}{5\times1.8+2} = 0.45$

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

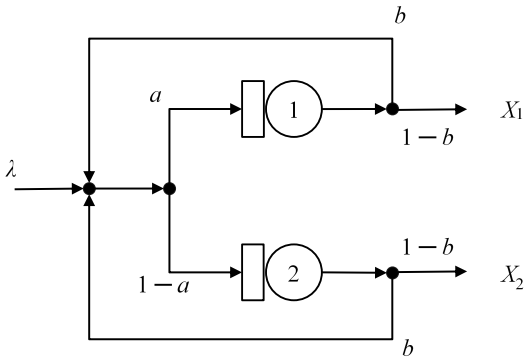
- number of stations K = 5
- service demand Dmax = 1.6 sec
- service demand Dtot = 3.3 sec
- think time Z = 0 sec
- number of users N = 5

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

A 5.94 sec B 6.60 sec ■ 8.00 sec D 21.14 sec

Explanation:
$\max(D_{tot} + (N-1) * D_{avg}, ND_{max} - Z) = \max(3.3 + (5-1) \times 0.66, 5 \times 1.6) = 8.00$

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 ■ $a/(1 - b)$ 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): 1.4
- Service time station A (Sa): 0.66 sec/tran
- Service time station B (Sb): 0.13 sec/tran
- Arrival rate (λ): 1.17 tran/sec

Which is the system response time?

A 2.329 sec/tran
B 2.549 sec/tran
■ 2.179 sec/tran
D 0.776 sec/tran