Student ID (*Matricola*)

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

Computing Infrastructures

Course 095897

P. Cremonesi, M. Roveri

Example exam

Last Name / Cognome:

....

First Name / Nome:

....

Answers must be given exclusively on the answer sheet (last sheet): DO NOT FILL ANY BOX IN THIS SHEET

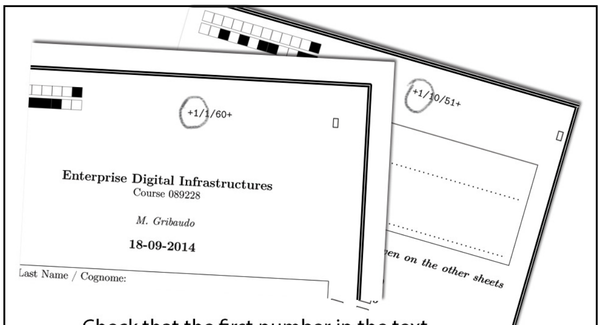
Students must use pen (black or blue) to mark answers (no pencil).
Students are permitted to use a non-programmable calculator.

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.

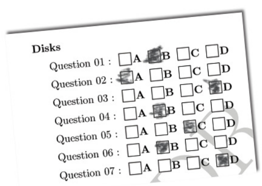
Students are NOT permitted to use mobile phones and similar connected devices.

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

Questions will 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

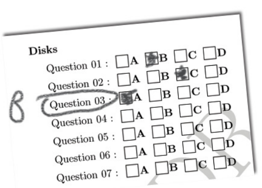


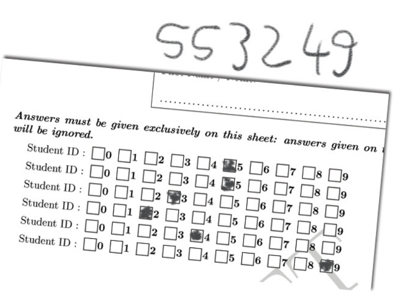
Do not use crosses to mark the answers!

Completely fill the box!

If you make a mistake:

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





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

Question 1 The Application binary interface (ABI) is composed by

- [A] User ISA and System ISA
- [B] User ISA and Libraries
- [C] System Calls and Application Software
- ■ User ISA and System Calls

Question 2 The User ISA encompasses:

- ■ The aspects of the ISA that are visible to the application program
- [B] The aspects of the ISA that are visible to the operating system and software libraries
- [C] The aspects of the ISA that are visible to the application program and operating system
- [D] The aspects of the ISA that allow to interact with the hardware for drivers, memory management and scheduling

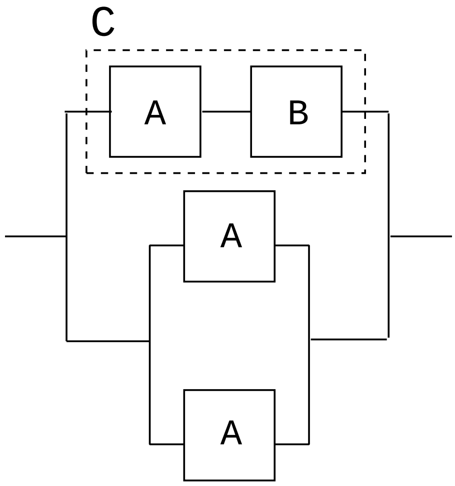
In the following questions we will assume that both failure and repair events follow exponential distributions.

Question 3
Consider a system built by two different components in parallel. Assume for component A: $MTTF_A = 244\ days$ and $MTTR_A = 1\ days$ and for component B: $MTTF_B = 451\ days$ and $MTTR_B = 5\ days$.
The reliability of the system at $t = 7\ days$ is equal to:

- [A] 0.989979
- [B] 0.987041
- ■ 0.999564
- [D] 0.984599

Explanation: $R_A(t) = e^{-t/MTTF_a}$ $R_B(t) = e^{-t/MTTF_b}$ $R_{sys}(t) = 1 - (1 - R_A(t)) * (1 - R_B(t))$

Question 4
Consider now the components A and B organized as in figure below. Assume for component A: $MTTF_A = 179$ *days* and $MTTR_A = 1$ *days* and for component B: $MTTF_B = 466$ *days* and $MTTR_B = 5$ *days*.



The MTTF without repair of block C is equal to:

- [ ] A 186.57731
- [ ] B 322.50000
- [x] C 129.32403
- [ ] D 14.04689

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

Question 5
Consider a system built by two different components in parallel. Assume for component A: $MTTF_A = 198$ *days* and $MTTR_A = 1$ *days* and for component B: $MTTF_B = 445$ *days* and $MTTR_B = 5$ *days*.
The $MTTF$ computed without repair of the previous system is equal to:

- [ ] A 198.00000
- [x] B 505.97045
- [ ] C 445.00000
- [ ] D 87972.97045

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

Question 6 With Bridged Networking:

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

Explanation: Lesson_3_Virtualization_B.pdf, slide 56

Question 7 The Nested Pages mechanism:

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

Explanation: Lesson_3_Virtualization_B.pdf, slide 31

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 NAT adapter;
- Host2 @ 10.0.0.1 run VM3, attached to the Bridge adapter;
- Host3 @ 192.168.0.2 runs VM4, attached to its NAT adapter.

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

[A] port-forwarding needs to be configured to expose services running on VM3

[B] a service on VM1 can reach a service on VM2 even without port-forwarding, as they are on the same host

■ 10.0.0.4 is a possible IP address for VM3

[D] none of the other answers is valid

Explanation: A service on VM1 can reach a service on VM2 only if port-forwarding is configured, even if they're on the same host, as they aren't on the same subnet. Moreover, VM4 is NATted, so a service it hosts on port X can be reached at: 192.168.0.2:X, while VM3 will have an IP address on the same subnet: 10.0.0.Y

Question 9
Consider a HDD with:

- data transfer rate: 240 MB/s
- rotation speed: 10000 RPM
- mean seek time: 20 ms
- overhead controller: 0.3 ms

The mean I/O service time to transfer a sector of 8 KB will be:

[A] 3.03 ms [B] 25.35 ms [C] 36.19 ms ■ 23.33 ms

Explanation: Mean latency: (1/2 round) * (60s/min) * 1/(10000 round/min) = 3.000 ms
Transfer time: (8 KB) / (240 * 1024 KB/s) = 0.032ms
Mean I/O service time = 20 + 0.3 + 3.000 + 0.032 = 23.33

Question 10
Consider the following RAID 1 setup:

- n = 2 disks
- MTTR = 8 days
- MTTF(one disk) = 1800 day

The MTTDL will be:

A 25312 days ■ 202500 days C 900 days D none of the others

Explanation: $MTTDL = \frac{MTTF^2}{n*MTTR} = 202500$ days

Question 11
Consider 2 groups (RAID 1) of 4 disks each (RAID 0), for a total of 8 disks in configuration RAID 0+1:

- MTTR = 4 days
- MTTF(one disk) = 2200 days

The MTTDL will be:

A none of the others B 151250 days C 605000 days ■ 37812 days

Explanation: $MTTDL = (2 * MTTF^2)/((totaldisks)^2 * MTTR) = 37812 days$

Question 12
Consider a closed system with the following data: average number of users: 24 ($N = 24$) average response time: 27 sec ($R = 27$), average throughput: 0.42 trans/sec ($X = 0.42$), average CPU service demand: 0.61 sec/trans ($D_{\text{CPU}} = 0.61$). Which is the average think time Z of a user?

■ 30.14 sec   B 39.34 sec   C 57.14 sec   D 12.34 sec

Explanation: Z = N/X - R

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

- station 1 response time: 11 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?

■ 14.00 sec   B 11.44 sec   C 0.63 sec   D 13.00 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: 17 ($N = 17$) average response time: 38 sec ($R = 38$), average throughput: 0.54 trans/sec ($X = 0.54$), average CPU service demand: 0.80 sec/trans ($D_{\text{CPU}} = 0.80$). Which is the CPU utilization?

[A] 0.03 [B] 0.73 ■ 0.43 [D] 0.57

Explanation: Ucpu = X*Dcpu

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

- Monitoring period: 5 minutes
- Disk utilization: 0.31
- CPU utilization: 0.55
- CPU demand: 0.40 seconds/transaction
- Number of I/O operations / transaction 8
- Response time: 20 seconds/transaction
- Number of users: 45

Which is the average think time of these users?

[A] 10.18 sec [B] 8.76 sec ■ 12.73 sec [D] 32.73 sec

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

Question 16
Consider the following measurement data for an interactive system

- measurement interval: 4 minutes
- number of users: 47
- number of servers: 23
- average response time per transaction: 17 seconds
- Dmax 2.0 sec/transaction
- Dtot 2.3 sec/transaction
- number of completed transactions: 78

On average, how many users are thinking?

☐ A 28.82 ☐ B 5.53 ■ 41.48 ☐ D 13.85

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

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

- number of stations K = 1
- service demand Dmax = 1
- service demand Dtot = 1
- think time Z = 2
- number of users N = 4

Which is the asymptotic upper bound of throughput?

■ 1 tran/sec ☐ B 0.8 tran/sec ☐ C 0.667 tran/sec ☐ D 2 tran/sec

Explanation: $\min(\frac{N}{D+Z}, \frac{1}{D_{max}}) = \min(\frac{3}{3.1+2}, \frac{1}{2.2}) = 0.45$

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

- number of stations K = 3
- service demand Dmax = 1.7
- service demand Dtot = 1.9
- think time Z = 1
- number of users N = 4

Which is the asymptotic upper bound of response time?

■ 7.60 sec [B] 5.71 sec [C] 5.80 sec [D] 5.06 sec

Explanation: $ND = 4 \times 1.9 = 7.60$

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

- number of stations K = 3
- service demand Dmax = 1.0
- service demand Dtot = 2.6
- think time Z = 3
- number of users N = 4

Which is the asymptotic lower bound of response time?

■ 2.60 sec [B] 1.81 sec [C] 1.54 sec [D] 1.76 sec

Explanation: $\max(D, ND_{max} - Z) = \max(2.6, 4 \times 1.0 - 3) = 2.60$

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

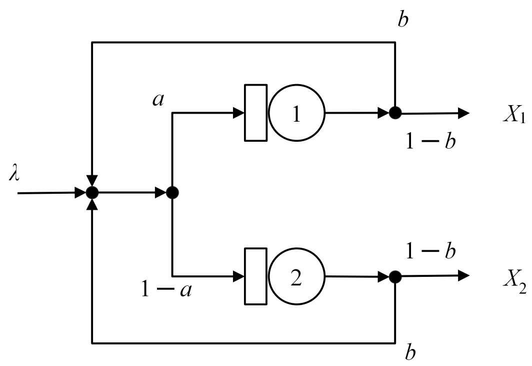
- number of stations K = 4
- service demand Dmax = 2.0
- service demand Dtot = 3.9
- think time Z = 1
- number of users N = 4

Which is the asymptotic lower bound of throughput?

[A] 0.50 tran/sec [B] 0.17 tran/sec [C] 0.26 tran/sec ■ 0.24 tran/sec

Explanation: $\frac{N}{ND+Z} = \frac{4}{4\times3.9+1} = 0.24$

Question 21 Consider the following open network, where a and b are routing probabilities. Which is the number of visits at station 2?



[A] $1 - a + b$ [B] $1 - a$ [C] $(1 - a) * b$ ■ $(1 - a)/(1 - b)$

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): 0.8
- Visits station B (Vb): 0.9
- Service time station A (Sa): 0.90 sec/tran
- Service time station B (Sb): 0.79 sec/tran
- Arrival rate (λ): 1.08 tran/sec

The system response time $R(\lambda)$ is:

A 6.893 sec/tran   B 1.430 sec/tran   C 7.526 sec/tran   ■ 6.360 sec/tran

Explanation: $R(\lambda) = \frac{D_a}{1-U_a} + \frac{D_b}{1-U_b} = \frac{S_a V_a}{1-\lambda S_a V_a} + \frac{S_b V_b}{1-\lambda S_b V_b} = \frac{0.90\times 0.8}{1-1.08\times 0.90\times 0.8} + \frac{0.79\times 0.9}{1-1.08\times 0.79\times 0.9} = 6.360$

Answer sheet:

Last Name / Cognome:

....

First Name / Nome:

....

Answers must be given exclusively on this sheet: answers given on the other sheets will be ignored.

Student ID : ☐0 ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9

Student ID : ☐0 ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9

Student ID : ☐0 ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9

Student ID : ☐0 ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9

Student ID : ☐0 ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9

Student ID : ☐0 ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9

Questions

Question 01 : ☐A ☐B ☐C ■D

Question 02 : ■A ☐B ☐C ☐D

Question 03 : ☐A ☐B ■C ☐D

Question 04 : ☐A ☐B ■C ☐D

Question 05 : ☐A ■B ☐C ☐D

Question 06 : ☐A ☐B ☐C ■D

Question 07 : ☐A ☐B ☐C ■D

Question 08 : ☐A ☐B ■C ☐D

Question 09 : ☐A ☐B ☐C ■D

Question 10 : ☐A ■B ☐C ☐D

Question 11 : ☐A ☐B ☐C ■D

Question 12 : ■A ☐B ☐C ☐D

Question 13 : ■A ☐B ☐C ☐D

Question 14 : ☐A ☐B ■C ☐D

Question 15 : ☐A ☐B ■C ☐D

Question 16 : ☐A ☐B ■C ☐D

Question 17 : ■A ☐B ☐C ☐D

Question 18 : ■A ☐B ☐C ☐D

Question 19 : ■A ☐B ☐C ☐D

Question 20 : ☐A ☐B ☐C ■D

Question 21 : ☐A ☐B ☐C ■D

Question 22 : ☐A ☐B ☐C ■D