 <b>EDITH COWAN UNIVERSITY</b> PERTH WESTERN AUSTRALIA		<b>INTERNAL</b>  Semester TWO, 20XX
Unit Code and Title	<b>CSI3344 Distributed Systems</b>	
Student Number	SURNAME/FAMILY NAME	OTHER OR GIVEN NAME/S
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**Duration**

Reading time	5 minutes
Working time	2 hours
Total time	2 hours 5 minutes

**Attempt**

All questions in Section A and Section B

**Marks**

100

**Type of Exam**

**Closed Book**

**Special Instructions**

- **Answers to question 1 (one) should be written in the computer answer sheet provided. Answers to all other questions MUST BE RECORDED IN THE EXAMINATION PAPER.**
- Use the 3-page booklet as scratch paper, or extra answer sheet when you need.
- The 3-page booklet **MUST** be returned with your exam paper for recording your exam mark.
- Calculator (non-programmable) is optional.
- There are a total of 16 pages.

**Students are not permitted to write on the examination or any other paper during reading time.**

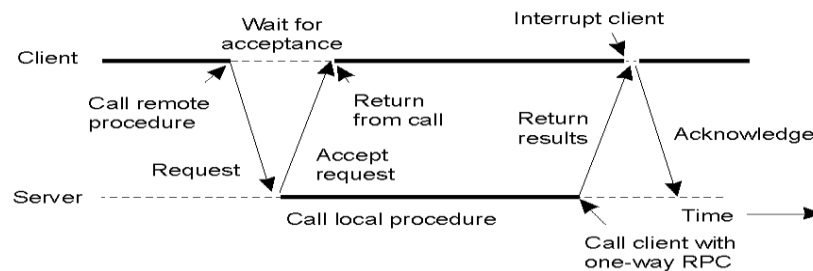
**Do not commence the examination until you are told to do so.**

## SECTION A (60 MARKS)

**Question 1** (30 marks): *Select ONE from the supplied answers for each of the following questions (if you think that more than one answer was correct, select the ONE that best matches the question). All answers should be written on the Computer Answer Sheets provided. The relevant question number must identify each of your answers (e.g., if the answer you have chosen for the first question is (B), then mark on (B) to question No. 1 on your Computer Answer Sheets). (Each question is worth 1 mark).*

1. The lowest layer at which messages (rather than packets) are handled is
  - (A) Session layer.
  - (B) Transport layer.
  - (C) Network layer.
  - (D) Data Link layer.
2. For a client-server system that potentially has Byzantine failures in its servers, how many replicated servers are needed to achieve 5-degree of fault tolerance?
  - (A) 5
  - (B) 6
  - (C) 10
  - (D) 11
3. If a distributed document system has 13 replicas, which of the following schemes is not a legal Gifford's Quorum Scheme?
  - (A)  $N_W = 6$  and  $N_R = 8$ .
  - (B)  $N_W = 7$  and  $N_R = 7$ .
  - (C)  $N_W = 8$  and  $N_R = 6$ .
  - (D)  $N_W = 9$  and  $N_R = 5$ .
4. An alias is
  - (A) an initial node.
  - (B) a directory node.
  - (C) a leaf node.
  - (D) a root node.
5. Setting up secure communication channel equals to
  - (A) authorization.
  - (B) authentication.
  - (C) encryption.
  - (D) auditing.
6. Which communication blocks the system?
  - (A) Persistent synchronous communication
  - (B) Persistent asynchronous communication
  - (C) Transient synchronous communication
  - (D) Transient asynchronous communication

7. The path name `n0:<home,ecu,scis,csi5117>` is equivalent to
- (A) `/home/ecu/scis/csi5117/`
  - (B) `/home/ecu/scis/csi5117`
  - (C) `/csi5117/scis/ecu/home//csi5117`
  - (D) `/scis/ecu/home`
8. The following diagram shows the interactions using
- (A) a traditional RPC.
  - (B) an asynchronous RPC.
  - (C) a deferred synchronous RPC.
  - (D) an one-way RPC.



9. Assuming that  $a$  and  $b$  are two separate processes, and  $L(a) < L(b)$ , then the relationship between  $a$  and  $b$  is
- (A)  $a \rightarrow b$ .
  - (B)  $b \rightarrow a$ .
  - (C) concurrent.
  - (D) uncertain.
10. In the Internet communication model, application layer includes \_\_\_\_\_ in the seven-layered OSI model.
- (A) Presentation, Session, and Transport
  - (B) Application, Presentation, and Session
  - (C) Application, Presentation, and Transport
  - (D) Application, Session, and Transport
11. In nested transactions, each subtransaction works on
- (A) the same database.
  - (B) a distributed database.
  - (C) a shared database.
  - (D) an independent database.
12. The perspectives of Openness refer to
- (A) hardware extensibility and information extensibility.
  - (B) hardware extensibility and software extensibility.
  - (C) software extensibility and information extensibility.
  - (D) hardware extensibility, information extensibility, and software extensibility.

13. In 2-tiered client-server architectures, which of the following organizations is actually a centralized system?
- (A) Remote Database.
  - (B) Distributed Application.
  - (C) Distributed Database.
  - (D) Distributed Presentation.
14. The short-cut of an entity, or the alias of that entity, is created using a leaf node, in which stored is
- (A) the information of the leaf node itself.
  - (B) the information of the outgoing edges.
  - (C) the relative path name of that entity.
  - (D) the absolute path name of that entity.
15. Multi-threaded servers enable the implementation of mechanisms for
- (A) concurrency control
  - (B) fault tolerance
  - (C) transparency
  - (D) all above
16. Replicas in a data store can be classified into three types, ie,
- (A) transient, server-initiated, and client-initiated.
  - (B) short-term, server-initiated, and client-initiated.
  - (C) intermediate, server-initiated, and client-initiated.
  - (D) permanent, server-initiated, and client-initiated.
17. Faults can be classified into
- (A) transient faults, intermittent faults, and hardware faults.
  - (B) software faults, data faults, and hardware faults.
  - (C) transient faults, intermediate faults, and permanent faults.
  - (D) transient faults, intermittent faults, and permanent faults.
18. Active security mechanisms include authentication, authorization, and
- (A) auditing.
  - (B) access control.
  - (C) encryption.
  - (D) identification.
19. To apply client-server lease approach in data propagation, \_\_\_\_\_ must be used.
- (A) stateful servers
  - (B) stateless servers
  - (C) concurrent servers
  - (D) iterative servers
20. Techniques for handling failures include
- (A) detecting, masking, tolerating, and recovering from failures.
  - (B) detecting, omitting, tolerating, and recovering from failures.
  - (C) detecting, skipping, tolerating, and recovering from failures.
  - (D) detecting, masking, omitting, and recovering from failures.

21. Processes and threads are created and managed at the layer of  
(A) application.  
(B) middleware.  
(C) operating system.  
(D) computer and network hardware.
22. An address is  
(A) an entity.  
(B) an access point.  
(C) referred by a name.  
(D) all above.
23. Fat client of two-tiered client-server architecture refers to  
(A) Distributed presentation  
(B) Remote presentation  
(C) Distributed application  
(D) Remote database
24. Which transient communication does not need the system to be blocked?  
(A) Receipt-based transient synchronous communication  
(B) Delivery-based transient synchronous communication  
(C) Response-based transient synchronous communication  
(D) Transient asynchronous communication
25. Heterogeneity in distributed systems applies to diversities in programming languages, implementations by different developers,  
(A) networks, hardware, and operating systems.  
(B) networks, operating systems, and organizations.  
(C) hardware, operating systems, and organizations.  
(D) networks, operating systems, and users.
26. Communication standards help achieving  
(A) Scalability.  
(B) Heterogeneity.  
(C) Transparency.  
(D) Security.
27. In the OSI communication model, which layer adds BOTH a header and a trailer to a frame?  
(A) Data link layer  
(B) Network layer  
(C) Physical layer  
(D) Transport layer
28. Routing is handled at the  
(A) Session layer.  
(B) Transport layer.  
(C) Network layer.  
(D) Data Link layer.

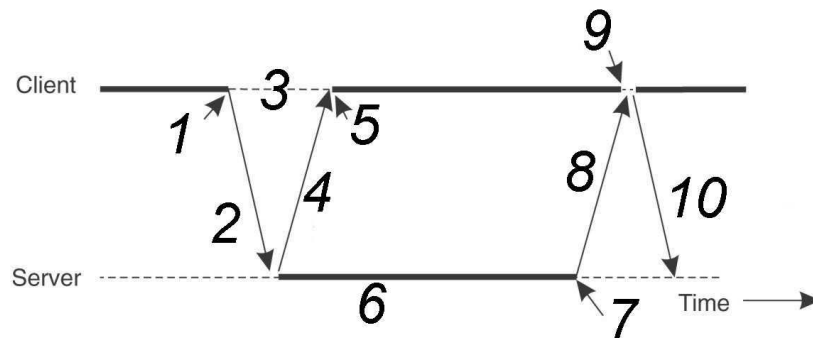
29. In update propagation, pull-based approach refers to
- (A) client-based protocol.
  - (B) server-based protocol.
  - (C) client-server lease protocol.
  - (D) invalidation protocol.
30. A file is replicated on 9 servers. Which of the following combination of write and read quorums (in form of  $(N_W, N_R)$ ) are permitted by the Gifford's voting algorithm (or Gifford's Quorum Scheme)?
- (A) (9, 1)
  - (B) (4, 5)
  - (C) (8, 1)
  - (D) All of above.

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**Question 2:** Answer the following questions. (15 marks)

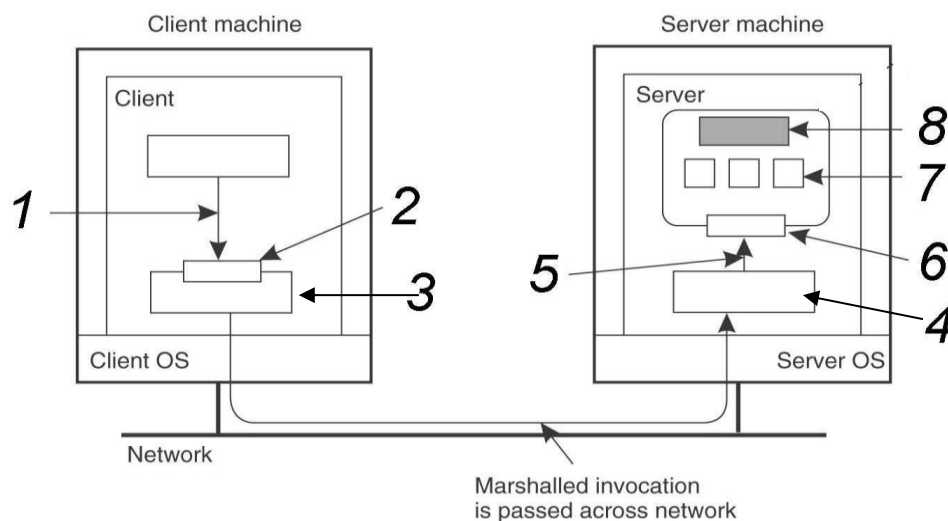
1. Remote Procedure Call (RPC)

The following diagram shows the interaction between a client and a server through a deferred synchronous RPC. The 10 actions are labeled by 1-10 in the diagram. Name/list all these 10 actions. (4 marks)



2. Remote Method Invocation (RMI)

The following diagram shows the general organization of a RMI between a client and a server. There are 8 units and/or actions labeled by 1-8 in the diagram. What do units 1, 2, 4 and 6 represent? (4 marks)



3. Briefly explain the characteristic properties of flat transactions. (3 marks)



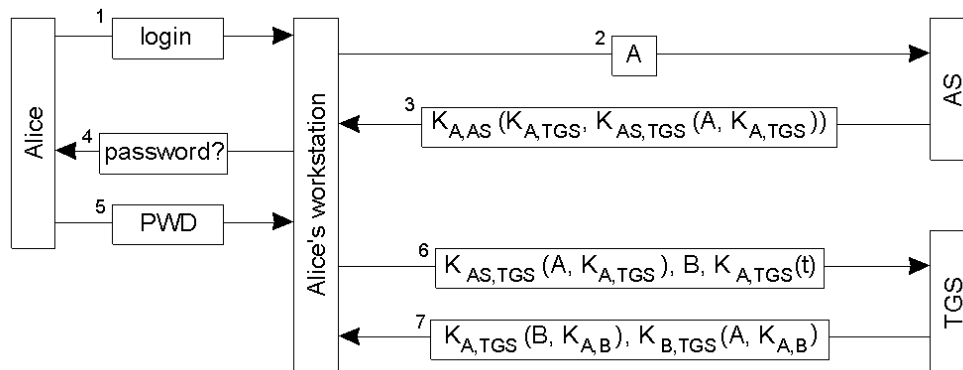
4. In this problem you are to compare reading a file using a single-threaded file server and a multithreaded server. It takes 15 *msec* to get a request for work, dispatch it, and do the rest of the necessary processing, assuming that the data needed are in a cache in main memory. If a disk operation is needed, as is the case one-third of the time, an additional 75 *msec* is required, during which time the thread sleeps. How many requests/sec can the server handle if it is single threaded? If it is multithreaded? (Note: 1 sec = 1000 *msec*) (4 marks)

**Question 3:** *Questions from Advanced Readings.* (15 marks in total)

1. Many distributed algorithms require the use of a coordinating process. To what extent can such an algorithm actually be considered distributed? Discuss your solutions. (4 marks)

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4. Authentication in Kerberos is shown below. Describe this authentication process in terms of the steps numbered in the diagram using the notations shown in the diagram. (4 marks)



**SECTION B (40 MARKS)**

*Answer the following TWO questions from this section. Each question is worth 20 marks.*

**Question 3. Synchronization and Consistency****(20 MARKS)**

- 1) What are the two simple points, on which the causal ordering is based?

(2 marks)

- 2) Draw a diagram showing three processes with some events, and then use vector timestamps to illustrate the Happened-before Relation. (6 marks)

3) The statement of causal consistency is:

*Writes that are potentially casually related must be seen by all processes **in the same order**. Concurrent writes may be seen in a different order on different machines.*

Given the following 5 sequences, **explain** which sequence is causally consistent, and which one is not.

(12 marks)

(a)

P1:	W(x)a		W(x)c	
P2:		R(x)a	W(x)b	
P3:		R(x)a		R(x)c
P4:		R(x)a		R(x)c

(b)

P1:	W(x)a		W(x)c	
P2:		W(x)b		
P3:			R(x)a	R(x)c
P4:			R(x)b	R(x)a

(c)

P1:	W(x)a			
P2:		R(x)a	W(x)b	
P3:			R(x)b	R(x)a
P4:			R(x)a	R(x)b

(d)

P1:	W(x)a			
P2:		R(x)a	W(x)b	
P3:			R(x)a	R(x)b
P4:			R(x)a	R(x)b

(e)

P1:	W(x)a			
P2:		W(x)b		
P3:			R(x)b	R(x)a
P4:			R(x)a	R(x)b

**Question 4. Fault Tolerance****(20 MARKS)**

- 1) A system goes down on average 6 hours in 100 days although it is shut down a day every 100 days for maintenance. What is the availability of this system? Is this system reliable? Why? (3 marks)

- 2) What are the permissible delivery orderings for the combination of FIFO and total-ordered multicasting in the following figure? (4 marks)

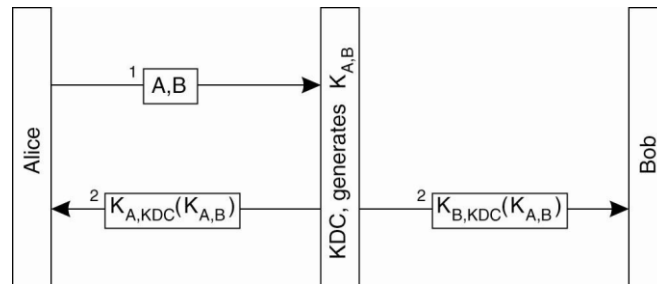
Process P1	Process P2	Process P3	Process P4
sends m1	receives m1	receives m3	sends m3
sends m2	receives m3	receives m1	sends m4
	receives m2	receives m2	
	receives m4	receives m4	

- 3) The following case for multicasting can be classified into more than one multicasting schemes. List all schemes that apply to the case, and explain your answer. (7 marks)

Process 1*	Process 2	Process 3	Process 4
Sends m1	Receives m1	Receives m1	Sends m3
Sends m2	Receives m2	Receives m2	Sends m4
	Receives m3	Receives m3	
	Receives m4	Receives m4	

\* P1 always has the priority.

- 4) The following figure shows the principle of using KDC. Why is it not necessary in the following figure for the KDC to know for sure it was talking to Alice when it receives a request for a secret key that Alice can share with Bob? (6 marks)



**END OF EXAMINATION PAPER**