**Family Name:** ..... **First Name:** .....

**Student ID:** ..... **Signature** .....

# NWEN 304 : Mid-term Test I

18 August 2023

## Instructions

- Time allowed: **50 minutes**
- Attempt **all** the questions. There are 50 marks in total.
- **In-person**: Write your answers in this test paper and hand in all sheets.
  **Remote**: Type your answers in the template file and submit to **Remote-Test-I** on the NWEN 304 submission system.
- If you think a question is unclear, ask for clarification.
- This test contributes 25% of your final grade.
- You may use dictionaries and calculators.
- You may write notes and working on this paper, but make sure your answers are clear.

| **Sections** | **Marks** | |
|---|---|---|
| 1. True/False | [10] | |
| 2. Multiple Choice | [10] | |
| 3. Multiple, Multiple Choice | [10] | |
| 4. Short Answer | [20] | |
| | TOTAL: | |

**Question 1. State True or False. Write your answer in the box provided. [10 marks]**

(a) **[1 mark]** Client-Server architecture does not allow direct communication between clients.

(b) **[1 mark]** The components of a distributed system have the ability to communicate with each other through a shared physical memory.

(c) **[1 mark]** The concept of `Watchers` in `Zookeeper` is based on the notion of client polling.

(d) **[1 mark]** An advantage of employing `asynchronous` communication via message brokers is that it enables services to exchange information even in instances where some of them are temporarily unavailable.

(e) **[1 mark]** For each new incoming request, `Node.js` spawns a new thread.

(f) **[1 mark]** Including multiple external `JavaScript` files into an `HTML` document could lead to the initiation of multiple `HTTP` requests to the server for fetching these files.

(g) **[1 mark]** One of the reasons for refraining from incorporating business logic in the Presentation tier of a 3-tier architecture is that the code executes in the client browser, which is both accessible and visible to the user.

(h) **[1 mark]** In `ZooKeeper`, by default all `zNodes` are `Ephemeral` unless otherwise stated.

(i) **[1 mark]** Distributed Hash Tables are used to support look-up operation in unstructured P2P networks.

(j) **[1 mark]** One of the reasons for the popularity of `Node.js` over `Java` in the development of data-intensive applications is `Node.js's` utilization of blocking I/O, in contrast to `Java's` use of non-blocking I/O.

**Question 2. Multiple choice questions. Each question has a single correct option. [10]**
**Write your answer in the box provided.**

(a) **[1 mark]** What does the following `JavaScript` code log?

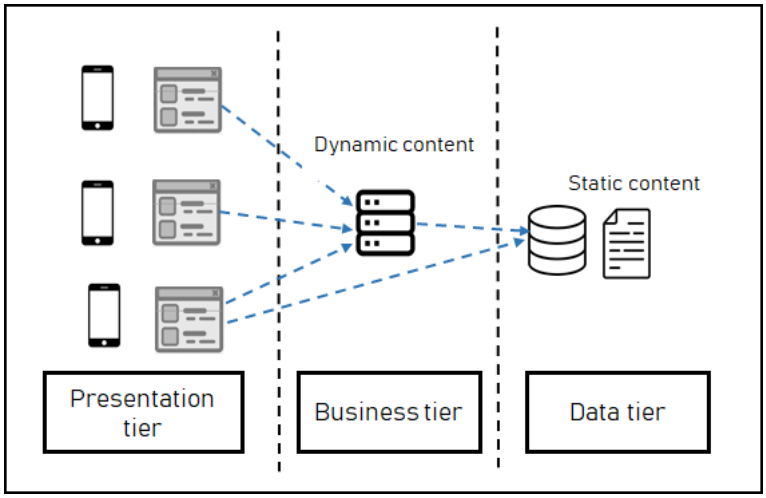
```
console.log(typeof[ ]);
```

(i) Array
(ii) Object
(iii) Undefined
(iv) Null

(b) **[1 mark]** Which one of the following operations is **NOT** idempotent?

(i) Deleting a record with a particular ID from the database.
(ii) Resetting a user's balance to 0.
(iii) Evaluating the absolute value of a number.
(iv) Removing the last record from a queue.

(c) **[1 mark]** Considering the architecture of the client-server application provided below, choose the appropriate statement from the following options.




(i) This is a well designed 3-tier architecture diagram.
(ii) This architecture is problematic as it contains both files and a database in the Database tier.
(iii) This architecture is problematic as the Presentation tier bypasses the Business tier and sends requests directly to the Data tier.
(iv) This architecture is problematic as both (ii) and (iii) are correct.

(d) **[1 mark]** Why is a 3-tier Architecture generally referred to as a Monolithic Architecture?

(i) Because all the business logic is concentrated in one deployable unit.
(ii) Because the entire frontend code runs on a single client device.
(iii) Because we can have only one database in the Data tier.
(iv) Because we can have only one codebase, and we can't break it into multiple modules.

(e) **[1 mark]** In which of the following two protocols is data read as a byte-stream?

(i) `UDP`
(ii) `TCP`

(f) **[1 mark]** What will be the output of the following `JavaScript` statement: `45 % -2`?

(i) `NaN`
(ii) `-1`
(iii) 1
(iv) Error

(g) **[1 mark]** Which one of the following P2P architectures is best suited for supporting distributed cache?

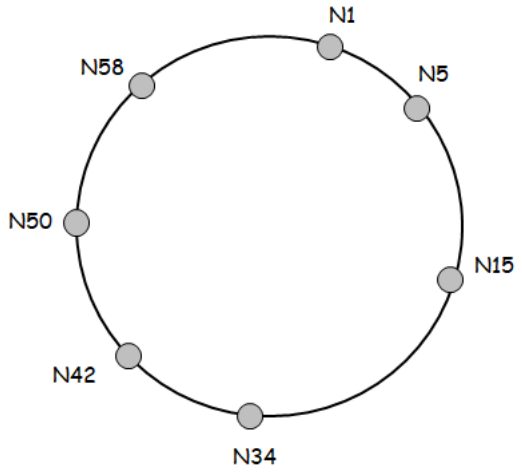
(i) Structured P2P
(ii) Flat unstructured P2P
(iii) Loosely structured P2P
(iv) Two level unstructured P2P

(h) **[1 mark]** What is the correct `JavaScript` syntax to change the content of the `HTML` element below?

```
<p id="demo">This is a demonstration.</p>
```

(i) document.getElementByName("p").innerHTML = "Hello World!";
(ii) document.getElementById("demo").innerHTML = "Hello World!";
(iii) document.getElement("p").innerHTML = "Hello World!";
(iv) #demo.innerHTML = "Hello World!";

(i) **[1 mark]** Consider the following representation of a consistent hash ring with a hash space of size $2^6$. Where should the key `k60` be assigned?




(i) `N58`
(ii) `N1`
(iii) `k60` cannot be assigned as the node with hash key `60` is not active.
(iv) `k60` cannot be assigned as no node with hash key `0` is active.

(j) **[1 mark]** Fill in the blank. In a P2P Chord network, the finger table maintained by a node holds a set of _____ entries for its sucessor node IDs.

(i) `log(N)`, where `N` is the number of active nodes in the network.
(ii) `log(N)`, where `N` is the number of keys to be stored.
(iii) `log(N)`, where `N` is the size of the hash space.
(iv) `log(N)`, where `N` is the number of inactive nodes in the network.

**Question 3. Multiple, multichoice questions. Each question has multiple correct options.[10] Write your answer in the box provided.**

(a) **[2 marks]** Which of the following statements are true about Apache `Zookeeper`?

(i) `Zookeeper` cluster follows a leader follower model.

(ii) To avoid single point of failure, `Zookeeper` is typically run as a cluster of $n$ nodes where $n$ is any integer greater than 1.

(iii) `Ephemeral Znodes` can serve as a means to store application-wide information that could be utilized by all active nodes within the computing cluster.

(iv) `Zookeeper` clients establish a connection to `Zookeeper` using the `TCP` protocol.

(b) **[2 marks]** Which of the following statements are true for consistent hashing?

(i) When a new node $n$ joins, it necessitates the transfer of certain keys from node $n$'s predecessor to node $n$.

(ii) When a new node $n$ joins, it necessitates the transfer of certain keys from node $n$'s successor to node $n$.

(iii) When a node $n$ leaves, it necessitates the transfer of certain keys from node $n$ to $n$'s predecessor.

(iv) When a node $n$ leaves, it necessitates the transfer of certain keys from node $n$ to $n$'s successor.

(c) **[2 marks]** Which of the following statements are incorrect in relation to `TCP` and `UDP` protocols?

(i) `TCP` provides throughput guarantees.

(ii) Both `TCP` and `UDP` provides throughput guarantees.

(iii) None of `TCP` and `UDP` provides throughput guarantees.

(iv) `TCP` guarantees delivery of data.

(d) **[2 marks]** Which of the following statements are true for `API` design?

(i) `RPC` based `APIs` are tightly coupled with the service implementation.

(ii) An advantge of `Resource API` over `Message API` is that `Resource APIs` use a small number of standardized methods to support various operations while `Message APIs` require distinct messages for each combination of domain entity and the associated operation.

(iii) `Asynchornous` communication involves sending a request and blocking while waiting for the response.

(iv) `Fetch API` is a `synchoronous API`.

(e) **[2 marks]** Which of the following statements are <u>true</u> for Node.js as a server side `JavaScript` run-time environment?

(i) Node.js uses a non-blocking I/O model.

(ii) Node.js is equally good for data intensive and compute intensive applications.

(iii) Node.js `HTTP` interface does not buffer entire requests or responses.

(iv) Node.js `HTTP` interface buffers entire request and responses.

**Question 4. Short answer questions** **[20 marks]**

(a) **[4 marks]** Explain the constituent architectural elements of an application's architecture.

(b) **[4 marks]** Suppose you are implementing a request-response service. Explain network error handling functionalities that you would implement (at the client and/or the server) to support the following operations:

(i) PUT request: The PUT request was unsuccessful in reaching the server due to a transient network issue.

(ii) POST request: The server effectively handled the POST request, the response to the POST couldn't reach the client due to a transient network error.

(c) **[6 marks]** Explain the following in relation to cluster coordination.

(i) **[2 marks]** The Herd effect.

(ii) **[4 marks]** How is the Herd effect managed in the implementation of leader election in a compute cluster using `Zookeeper` as the cluster coordinator?

(d) **[6 marks]** Trace out the steps of the Chord protocol for supporting the look-up service in a P2P network implemented using a hash space of size $2^7$ .

(i) **[1 marks]** Draw the hash ring to accommodate a hash space of $2^7$ with `N1, N10, N30, N45, N54, N87, N90, N100` and `N120` as the active nodes in the network.

(ii) **[3 marks]** Calculate the finger table for `N87`.

(iii) **[2 marks]** Illustrate the process of look-up for `K26` initiated at `N87`.

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**SPARE PAGE FOR EXTRA ANSWERS**

Cross out rough working that you do not want marked.
Specify the question number for work that you do want marked.