1. Mid Sem Exam Paper: 1

Birla Institute of Technology & Science, Pilani

Work Integrated Learning Programmes Division

Second Semester 2023-2024

Mid-Semester Test

(EC-2 Regular)

Course No.   : SE ZG583

Course Title   : Scalable Services

Nature of Exam   : Closed Book

Weightage   : 30%

Duration   : 2 Hours

Date of Exam   : 16/03/2024 (FN)

> No. of Pages   = 2

Note to Students:

1.   Please follow all the *Instructions to Candidates* given on the cover page of the answer book.
2.   All parts of a question should be answered consecutively. Each answer should start from a fresh page.
3.   Assumptions made if any, should be stated clearly at the beginning of your answer.

Q.1   What is CAP theorem? In a NoSQL Databases like Amazon DynamoDB which of the properties of CAP theorem are prioritized and Why?   **3Marks**

Q.2   What is Horizontal and Vertical Partitioning? Explain. Apply Horizontal and Vertical Partitioning to the data given below and show what will the data look like after the partition.
4Marks

EmpID	FirstName	LastName	Email	Phone	Department	Position	HireDate	Salary
101	Alice	Johnson	alice.j@email.com	555-1234	IT	Software Engineer	2022-01-15	$80,000
102	Bob	Smith	bob.smith@email.com	555-5678	HR	HR Specialist	2021-09-10	$65,000
104	David	Lee	david.lee@email.com	555-4321	Finance	Financial Analyst	2021-12-01	$85,000
107	Grace	Davis	grace.d@email.com	555-6789	Marketing	Marketing Manager	2021-11-10	$100,000
108	Henry	White	henry.w@email.com	555-3456	Finance	Senior Accountant	2022-04-03	$88,000

Q.3   Analyze the role of CDNs in video streaming services. How do CDNs optimize the delivery of video content, and what challenges may arise in this context?   **3Marks**

Q.4   Within the Azure Service Fabric lifecycle, there is a state for service replica known as the In-built replica. Elaborate on the various types of inbuilt replicas.   **2.5Marks**

Q.5   What is a load Balancer? Explain different types of load balancers.   **2.5Marks**

Q.6   What roles does a distributed cache play, and what advantages does it provide?   **3Marks**

Q.7   Uber started its service from San Francisco with a monolithic architecture. The solo repo held the business logic for matching drivers and riders, running background checks, taking care of the billing and the payment, and all the other related functionalities.
As it became popular Uber wanted to expand to multiple cities which required a lot of changes in the code but with every change there was always a risk of cascading impact of the code change on the existing functionalities. Single repo implementations needed serious regression testing after deployments. Adding new features was cumbersome. All of these issues needed more developer resources.

Current Architecture:
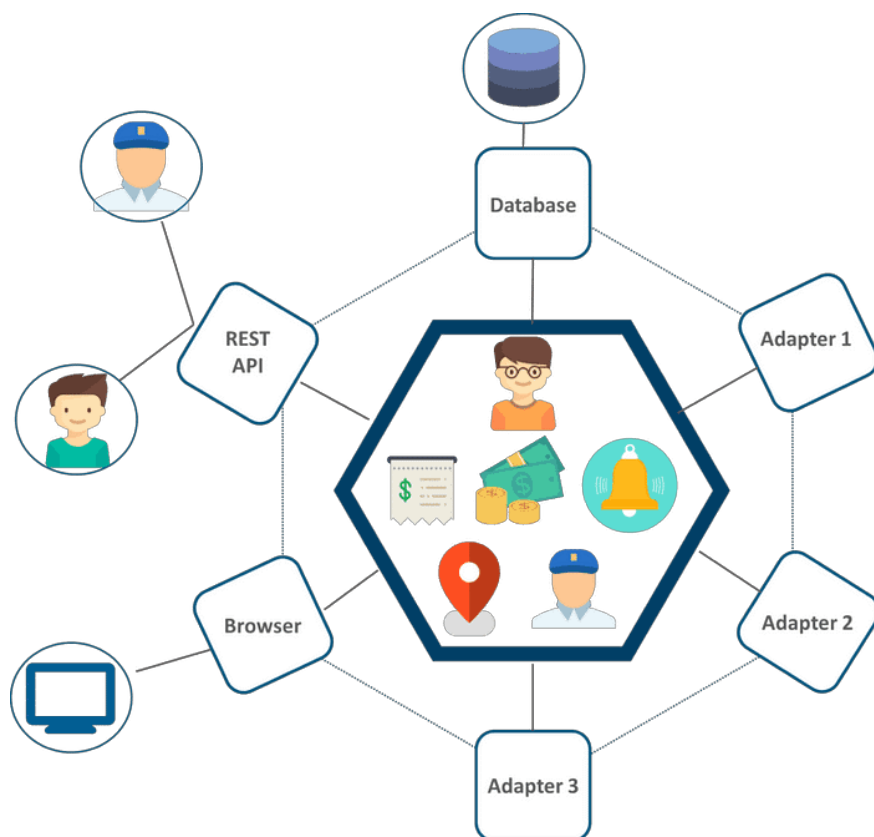
a. Which components in the current architecture require modification to enhance scalability, enabling it to extend its coverage to multiple cities?   **2.5marks**
b. To seamlessly transition from the existing architecture to the new one, which architectural pattern can be employed? Explain   **2.5marks**
c. Identify any five major system operations from this case study. Explain them briefly.   **2.5marks**
d. Identify any four services for this case study. Explain briefly.   **2.5marks**

e. Map the identified system operations to their respective services. Justify the mapping.
2marks

Birla Institute of Technology & Science, Pilani
Work Integrated Learning Programmes Division
Second Semester 2023-2024

2. Comprehensive Examination

(EC-3 Regular)

Course No.   : SE ZG583
Course Title   : Scalable Services
Nature of Exam   : Open Book
Weightage   : 40%
Duration   : 2 ½ Hours
Date of Exam   : 18/05/2024(FN)

No. of Pages   = 3

Note to Students:

1. Please follow all the *Instructions to Candidates* given on the cover page of the answer book.
2. All parts of a question should be answered consecutively. Each answer should start from a fresh page.
3. Assumptions made if any, should be stated clearly at the beginning of your answer.

Ques1. Your team needs to design a platform where users could capture and share moments through photos and videos (similar to Instagram). Following are the functional requirements for this platform

- User Authentication: Users should be able to create accounts, log in securely, and manage their profiles.
- Content Creation: Users should be able to capture photos or record videos using the app's camera functionality. They should also have the option to upload images or videos from their device's gallery.
- Content Sharing: Users should be able to share their photos and videos with their followers and other users on the platform. They should have options to add captions, tags, and location information to their posts.
- Notifications: Users should receive notifications for likes, comments, mentions, and new followers to stay updated on interactions and engagement with their posts and profiles.
- Privacy and Security: This application should implement privacy controls to allow users to manage the visibility of their posts, profile information, and interactions.
- Analytics and Insights: This application should provide users with analytics and insights into the performance of their posts, including metrics such as likes, comments, shares, and reach.
- Shopping: This feature will allow businesses to sell products directly to users within the application. Users can browse products, make purchases, and complete transactions without leaving the platform.

a) To design the architecture of this application which one of the below-mentioned patterns will you prefer and why?   **2marks**
    - SOA
    - Monolithic
    - Microservices
b) What is more appropriate in the below-given scenarios eventual or strong consistency? Justify your answer.   **3marks**
    - For the posts created by the user
    - For transactions related to shopping
c) How will you provide scalability for the content sharing feature? Justify.   **2marks**

Ques2. What are X-axis, Y-axis, and Z-axis scaling? Explain the same by taking Youtube architecture as an example.   **4.5marks**

Ques3. You need to design the architecture for an online jewellery platform that will be used by the customers across the globe.

Functional Requirements:

User Authentication and Authorization:
- Users should be able to create accounts, log in, and log out securely.
- Differentiate between customer and admin roles with appropriate permissions.
- Allow users to update their profiles and reset passwords if forgotten.

Product Management:
- Admins should be able to add, edit, and delete jewellery products.
- Products should be categorized logically for easy browsing.
- Provide search and filter functionality to help users find products efficiently.

Shopping Cart and Checkout:
- Users should be able to add items to their shopping cart and adjust quantities.
- Allow users to proceed to checkout securely, providing options for shipping and payment.
- Support multiple payment methods (credit/debit card, PayPal, etc.).

Order Management:
- Users should receive confirmation emails upon placing an order.
- Admins should be able to view and manage orders, update order status, and generate invoices.
- Provide order tracking functionality for users to monitor the status of their orders.

Content Management:
- Admins should be able to manage static content such as About Us, FAQs, and policies.
- Allow for the addition of promotional banners, featured products, and special offers.

a) Identify 4 major business capabilities in this case study and map them to services. Justify the mapping.
   3**marks**

b) How will you ensure the security of different user-related data and financial transaction-related data? Justify.   **2marks**

c) Imagine you have designed a complete microservices-based application for this case study. Propose a deployment strategy for this and explain how can this strategy help in catering to the varying user load during the sale season.   **3marks**

d) Suppose one part of the application was facing multiple errors. How can your architecture ensure that the failure is not propagated to any other part of the system? **2marks**

e) Suggest two design approaches to maximize service reliability in this scenario.   **3marks**

f) Assume, that you have recently made some changes to a service. How do you handle code integration in a microservices ecosystem to ensure that changes in one microservice do not break others?
   2marks

Ques4. Netflix employs a highly distributed and scalable microservices architecture to deliver streaming content to millions of users worldwide. The different components of the system are divided into small, independent services. Each service handles a specific functionality, such as user authentication, recommendation algorithms, content delivery, and billing.

a) In what ways could Netflix leverage Kubernetes for its deployment processes?   **2marks**

b) Suppose Netflix is using Kubernetes for deployment then for the user service should it use persistent or non-persistent storage? Justify   **2marks**

c) What type of scalability (HPA, VPA or cluster Auto scalar) will we use in the below-mentioned scenarios? Justify your answer.   **4marks**
   - Netflix may have microservices with fluctuating resource requirements or workloads that periodically require more memory or CPU resources.

- Netflix's Kubernetes clusters may experience capacity constraints during peak usage periods or when deploying new services or updates.

Ques5. You're developing a simple blogging platform called "Blogify." The platform consists of two main services:
Web Application Service: This service serves as a web application for users to view and interact with blog posts.
Database Service: This service hosts the database where blog posts and user data are stored.

a) Create dockerfiles for Web Application and Database service and make the required assumptions about the implementation level details.   **3marks**

b) How can you use the above-created files for the deployment of this application on Docker desktop?
                                    2.5marks