Faculty of Computers and Artificial Intelligence
Cairo University

Final Exam

Department: Software Engineering Undergrad Program
Course Name: Software Engineering-3 **Date: Mar. 13th, 2021**
Course Code: CS454 **Duration: 2 hours**
Examiner: Dr. Soha Makady **Total Marks: 60**

تعليمات هامة

- حيازة التيلفون المحمول مفتوحا داخل لجنة الأمتحان يعتبر حالة غش تستوجب العقاب وإذا كان ضرورى الدخول بالمحمول فيوضع مغلق فى الحقائب.
- لا يسمح بدخول سماعة الأذن أو البلوتوث.
- لايسمح بدخول أي كتب أو ملازم أو أوراق داخل اللجنة والمخالفة تعتبر حالة غش.

This exam is a CLOSED book exam. The exam comes in 4 pages.

Question 1 [11 marks]

(a) **Explain** two differences between processes and threads. **[2]**
(b) **Explain** two differences between using the Thread class and the Runnable interface within multi-threaded programming.**[2]**
(c) Explain the difference between layers and tiers using a system example of your own choice.**[2]**
(d) **Explain** two differences between application servers and web servers. **[2]**
(e) **Explain** three differences between monolithic and microservice-based applications. **[3]**

Question 2 [8 marks]

(a) [4 marks] Categorize each of the following requirements **according to the sub-categories** of non-functional requirements explained within the course. You must provide a written explanation for your answer. ***If no explanation is provided, no mark will be given for the corresponding part.***
    (i) Within Acadox learning management system, the teaching assistant of the course “CS 101” should not be able to ban a student from accessing the course’s content. Such banning should only be done by the course instructor.
    (ii) SatWatch (a satellite-moderated watch) should display the correct time zone within 5 minutes of the end of a GPS blackout period.
    (iii) The ARENA system must support the kick-off of many parallel Tournaments (e.g., 20), each involving up to 64 Players and several hundreds of simultaneous Spectators.
    (iv) Money transfer between different banks must be guaranteed to succeed with no money loss.
(b) Consider an application that can process at most 1000 customer transactions per second. Explain how you would scale that application to support 10000 customer transactions per second. You need to explain **two options for scalability**: scaling out and scaling up. **[4]**

Question 3 [9 marks]

(a) **[2 marks]** When creating a **Java Socket**, a port number is required. What is the role of that port number in this process?
(b) Suppose that two servers (programs) run on a specific computer: a chatting program (server 1) and an Uber-like transportation program (server 2). Consequently, server1 is initially bound to port number 1024, while server2 is initially bound to port number 1056. The servers waits for clients to make a connection request.
    (i) **[1 mark]** Why is server 2 bound to a different port number from the port number of server 1?

(ii) **[2 marks]** Assume that Client 1 makes a connection request using TCP/IP to server 1, and Client 2 makes a connection request using TCP/IP to server 2. Explain, **using port numbers**, how the connection between each client and its target server would be established so that each client can use the application independently. Make any additional needed assumptions.

(c) [**4 marks**] Classify each of the following applications as an enterprise application, or not? You must justify your classification, or else no grade would be given.

i. A program that calculates the factorial of numbers between 1 and 100,000.
ii. An online banking system for a bank with thousands of customers, and a series of branches.
iii. A program that simulates a 3D representation of X-rays.
iv. An online payment gateway for a credit card company that processes millions of transactions per day.

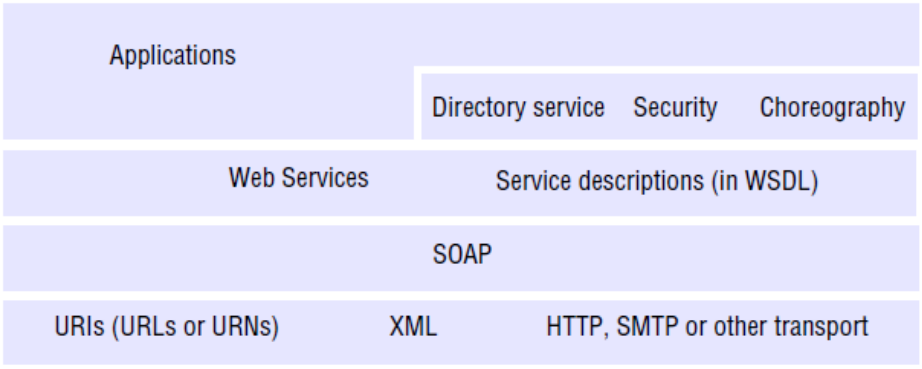
Question 4 [11 marks]

(a) [3 marks] **Identify** the most appropriate architectural style for each of the following different systems' descriptions. You must provide a written explanation for your answer. ***If no explanation is provided, no mark will be given for the corresponding part.***

i. Need software for managing and providing different kinds of information (weather, location, points-of-interest etc.) to app- and web-developers. The information will be gathered from various sources and processed by through the software. The software should provide open data access to anyone who wants to use the information through standard APIs.
ii. Need software for a smartphone game where players can compete against each other through Bluetooth (no need to access the Internet)
iii. Need a web-based system where the centralized computing resources are divided into three parts: A *presentation* part which displays information related to various services, an *application* part – which controls the system's functionality and carries out the processing, and a *data* part where data is accessed, stored, changed and maintained

(b) [**6 marks**] In a classic web-based application Java EE application architecture, there are four tiers: client tier, web tier, business logic tier, and enterprise information systems (EIS) tier. **Define** each of those tiers. **Pick** an enterprise application and **identify** what would be present in each tier of that application using that same architecture.

(c) [**2 marks**] Consider the following figure that explains the web service infrastructure and components. Explain what is meant by **directory service,** and **Service descriptions.**



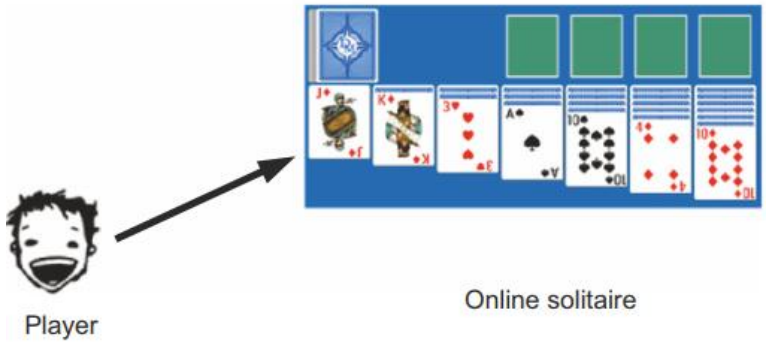
Question 5 [10 marks]

We discussed several concepts related to the use of distributed components within enterprise applications. Among the studied concepts were **session beans**, and **containers**.

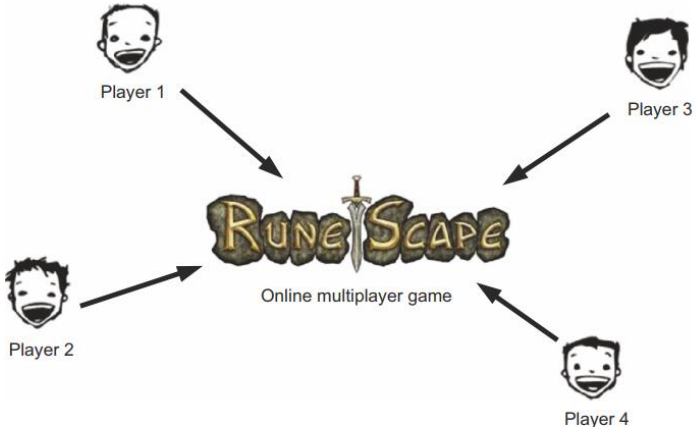
(a) [3 marks] Explain the difference between the three types of session beans that were studied.

(b) [3 marks] For each of the following system requirements, **identify** the most a suitable type of session bean, and **justify** why you chose that session bean type specifically. If no justification is given, no grade would be given.

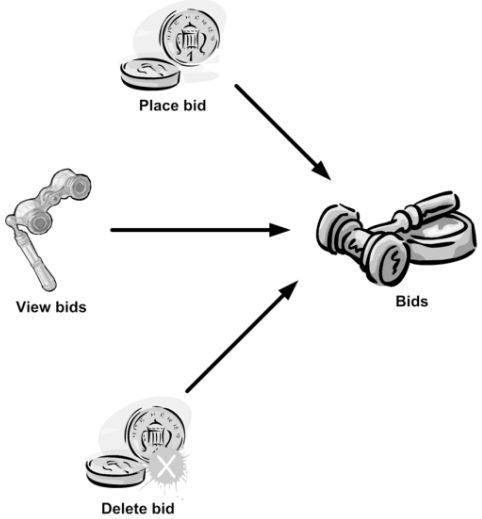
i. An online Solitaire game allows one player to play the game while enforcing a persistent connection between the client (player) and the server. Multiple players can be playing Solitaire at the same time, but none share the same game.



ii. Consider an online multiplayer that is concurrently accessed by all players, and stores the shared state common to all players. There is only one live instance of the game that all players connect to.



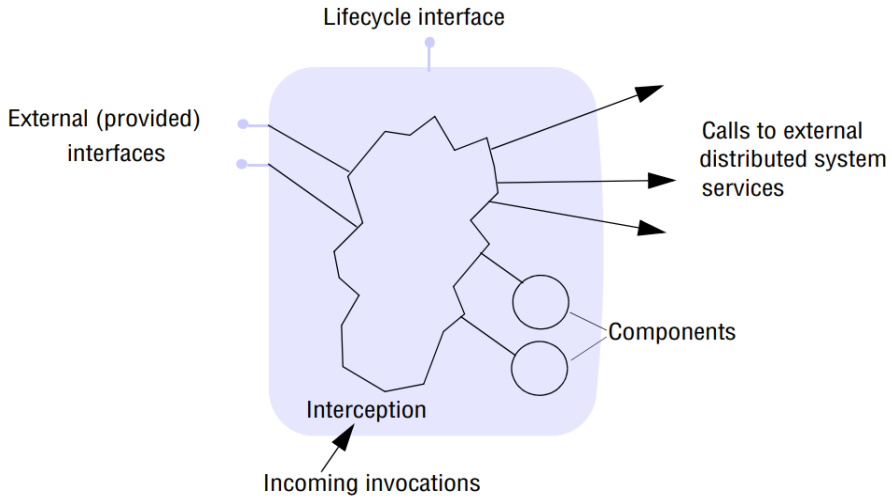
iii. My-E-bay is an online buy/sell application, where buyers can post their items for sale. Interested shoppers can bid (يزايد) on an item, or view the current bids (مزايدات). My-E-Bay administrators can view or remove bids. What kind of sessions beans could be most appropriate for the bid-related actions shown in the figure below.



(c) One of the main limitations of using distributed objects (like RMI) was **the lack of separation of distributed concerns**. Such limitation was overcome by using distributed components and containers.

i. **[2 marks] Explain** what is meant by distributed concerns. **Give one example** for a distributed concern.

ii. **[2 marks]** Given the following figure for the use of containers along with distributed components, explain how using containers and distributed components could overcome the "lack of separation of distributed concerns".



Question 6 [11 marks]

Consider a **web-based** application that allows users to find nearby restaurants, place a reservation, cancel a reservation and make a review on a specific restaurant.

(a) **[3 marks] Sketch** a diagram to show a layered architecture for such a system. **Explain** your diagram.

(b) **[3 marks]** Consider that such a system would be changed to allow using different devices besides the web-based application (e.g., using an Android mobile application or an iOS mobile application). **Sketch** a diagram for how your proposed design in part (a) would be modified to achieve such change. You need to **justify** and **explain** your modification.

(c) **[3 marks]** Consider that such system would be updated once more to allow placing a different number of workloads (i.e., user requests) on different functionalities simultaneously. **Sketch** a diagram for the design of such a system to achieve that change. You need to **justify** and **explain** your design.

(d) **[2 marks]** Consider that such system would allow a variety of different devices with different information needs from the provided system's functionality. For example, a mobile app version of the application would only show a subset of the restaurants based on two main filters: the location of those restaurants within the same location of the cell phone of the user, and the restaurants where the user has given his contact information when he physically visited them before. On the contrary, a web-based version of the application would not apply any of those filters. **Sketch** a diagram for how your proposed design in part (c) would be modified to achieve such change. You need to **justify** and **explain** your modification.

End of Exam