Birla Institute of Technology & Science, Pilani
Work-Integrated Learning Programmes Division
Second Semester 2021-2022

Comprehensive Examination
(EC-3 Regular)

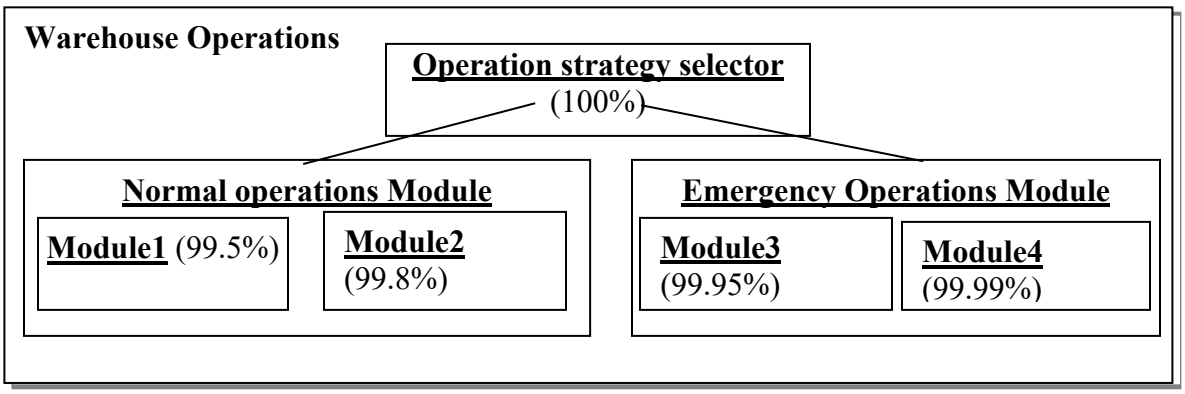
Course No.	: SE ZG651
Course Title	: SOFTWARE ARCHITECTURES
Nature of Exam	: Open Book
Weightage	: 45%
Duration	: 2 Hours
Date of Exam	: Saturday, 21/05/2022 (FN)

No. of Pages = 8
No. of Questions = 4

Note:
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 Set. (A) 12 Marks

a) Consider the back-end warehouse operations module of a software as a service system for which you need to assess its availability. The application has been in production for a sufficiently long time, and it is possible to compute the availability information of each module. The module-view showing a few of its critical modules is presented below with the availability values. The operating strategy selector module never fails (100% availability). The warehouse system can function without failure if the operation strategy module is available and either the Normal operations module or the Emergency operations module is available. The Normal operations module functions only if both "Module1" and "Module2" are available. Similarly, the Emergency operations module is functional only if both "Module3" and "Module4" are available. Availability of Module1, Module2, Module3 and Module4 are shown in the diagram. Calculate the probability of normal functioning (i.e. availability) of the normal operations module, and the emergency operations module, and then compute the probability of normal functioning of the warehouse operations module. The answer must be at least up to 3 places after the decimal point. Answer like 1, 0.9. 0.99 is not correct. [7]



b) Security is one of the most important quality attributes. Take an example of a remote proxy that performs the function of protection and firewall, to explain the implementation of security tactics. For the proxy take an example of a client accessing the external data (over the network) (Hint: Use of proxy pattern). Please explain the working of this architectural solution in the context of the scenario: "Connect with original to get the latest data when the data in proxy is stale." [3]

c) Assume that, during the setup of an IPhone, we must incorporate a *setup option: "Select your language and country*." So that the application can be used in various countries in various languages. Which of the quality attributes and the associated tactics is being achieved by this option? Explain your answer. [2]

Q.1 Set. (B) 12 Marks

a) A single lift control system (LCS) controls more than one lift. LCS software module controls the electrical input to control and manage the movement of each lift car. LCS module uses a communication bus to send in commands and receive data from each LC software, running in each lift car. LCS server runs on a Windows server. The LCS GUI interface, which interacts with a server, is used to monitor, configure, and control the LCS. An LC software is in a programmable firmware, installed in each lift car.

Each lift car has sensors- namely, the laden weight sensor, current-floor sensor, speed sensor, position sensor and power-failure sensor. LCS receives these sensor values in real-time from each LC. LCS can also configure these sensors and control these sensors. An emergency light is installed which switches on when the power fails. This light is controlled by the LCS. Each lift car has an auto-rescue-device (ARD) which receives current floor, and current location from the LC. ARD is controlled by LCS. LCS is to be designed for handling each LC in a separate thread, where the sensor data collection, data processing and controlling for each LC will be handled in a separate thread. The operations team is expected to use the GUI from a different system to connect to the LCS server.

ARD can sense the power failure and the loss of communication with LCS. In that case ARD can take the car to the nearest lower floor. Each LC also has a user-interface which displays the present floor, present weight of the lift, speed of the lift and it shows time-of-day. An input interface is present which allows certain inputs from the users for floor request, alarm and internal light switch on/off.

i. Draw a deployment diagram using UML notations for the LCS that is managing 3 lift cars. [4]
ii. Draw a module view of the LC and LCS, describing various submodules and their responsibilities. [4]

b) There are two applications with the following operational failure characteristics on a given day. Application 1 crashed 10 times and it took 5min to restart every time after the crash. Application 2 crashed 20 times and it took 2min to restart. Show with elaborate calculation which one has a better availability? [4]

Q.1 Set. (C) . 12 Marks

a) Consider a computer system that has a scanner installed. Assume that the OS (follows a Microkernel architecture), has already detected a scanner and is ready to be used. The OS is a particular flavor of UNIX. Now consider a scenario that a user uses GUI application to scan a document.

i. Identify the essential modules for this problem [4]

ii. Map each module with the components of the Microkernel pattern. [4]

b) Question paper Correction and Reporting Application Assume that you are asked to design a system having the following display input and output requirements:

Input of the system is a set of answers for multiple choice questions (MCQ). This input is provided in a comma separated format with each line providing the question number and the solution as marked by the person taking the test.

i) This input is processed against the answer template and the following data is made available

- Student ID (which is also the Key), total number of correct and wrong answers for each answer sheet, total number of unmarked answers for each answer sheet, total number of answer sheets validated

ii) The following data is shown on the display in real time

- A bar graph of the number of students who have passed and failed the test with two bars. Color is configurable from the same display window
- Analysis of total number of unanswered questions from each paper in the form of Student ID and total un-answered in a tabular format

Based on the details provided above, identify the modules for this problem that play the roles of M, V and C. [4]

Q.2 Set. (A) 12 Marks

A software development for Self-Driving-Missile-System (SDMS) in embedded scenario is carried out. The said software architecture of SDMS is developed by considering the following issues of reusability:

i) The application could be ported to new hardware by changing only the Hardware-Interface layer and parts of the SDMS interface architecture.

ii) The architecture would remain useful in defining other domain-specific software architectures, especially for embedded control applications.

a) What type of facility is justifiable out of closed-layer and open-layer in this layered architecture? Explain briefly. [4]

b) Can you highlight any possibility of tending monolithic applications in this layered architecture in the context of reusability? [4]

c) Give one example of mock testing for each layer after being ready for reusability for any other control system. [4]

Q.2 Set. (B) 12 Marks

A software development for Self-Driving-Missile-System (SDMS) in embedded scenario is carried out. The said software architecture of SDMS is developed by considering the following issues of reusability:

i) The application could be ported to new hardware by changing only the Hardware-Interface layer and parts of the SDMS interface architecture.

ii) The architecture would remain useful in defining other domain-specific software architectures, especially for embedded control applications.

a) Can any advantage be found if business layer and persistence layer are combined? Justify your answer. [4]

b) Is there any sort of possibility to make the layers autonomous? Justify your answer. [4]

c) Is it possible to deploy SDMS for self-driving cars? If it is, then highlight what type of evaluation of alternatives is required to be made? [4]

Q.2 Set. (C) 12 Marks

A software development for Self-Driving-Missile-System (SDMS) in embedded scenario is carried out. The said software architecture of SDMS is developed by considering the following issues of reusability:

i) The application could be ported to new hardware by changing only the Hardware-Interface layer and parts of the SDMS interface architecture.

ii) The architecture would remain useful in defining other domain-specific software architectures, especially for embedded control applications.

a) The developer of SDMS split the application logic into smaller components and spread across several networks. Can this situation lead to the design of multiple tiers in the application layer? Justify your answer. [4]

b) If the system requires faster network communications, high reliability and great performance, then is it possible for this layered architecture to support these? Justify your answer. [4]

c) The scalability and extra dimensions of functionality can be achieved with the multi-layered architecture. How can this statement be justified for this embedded system? [4]

Q.3 Set. (A) 12 Marks

MRF pace foundation was a fast bowlers training Academy. Since This idea was very successful the idea was further expanded to bring up potential fast bowlers from the sub-continent region that included players from India, Pakistan, SriLanka and Bangladesh from which Pakistan later opted out.

This training academy was named as Subcontinent Pace Academy (SPA).

Initially players from small district HQs are to be trained and based on their performance the best players reach the HQ of the academy.

Case Study on Device Integrated SMAC as Solution for Subcontinent Pace Academy (SPA). This application is named as GroomigFastBowlers This application allows the coach and trainer to track their daily progress. The Coach shall access the global data and assign an assistant coach for set of fast bowlers who shall monitor each of bowler's fitness development and the progress of their bowling abilities via their mobile device. The bowlers shall have the wearable device (MyMonitor) with them and execute the bowling training programme.

MyMonitor shall be integrated with the GroomigFastBowlers application that enables assistant coach or coach to get real-time updates on the training statistics in their mobile app.

Based on the mobile app and wearable input, the web application shall generate the result and statistics for each bowler.

a) Define the term SMAC. [2]
b) Explain how this application fits into a SMAC framework. [3]
c) Show the relation between the cloud, mobile, social and analytics components diagrammatically by giving a view of the application architecture. [4]
d) Explain CAP theorem in the context of this application. [3]

Q.3 Set. (B) 12 Marks

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Based on the mobile app and wearable input, the web application shall generate the result and statistics for each bowler.

a) State the need for the SMAC framework [2]
b) How do the cloud, mobile, social and analytics components fit into this application? [4]
c) State the need for CAP theorem in the context of this application. [3]
d) Define the terms CA and P and the tradeoff between these terms in this application [3]

Q.3 Set. (C) 12 Marks

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Based on the mobile app and wearable input, the web application shall generate the result and statistics for each bowler.

a) Does this application fit into a SMAC framework? Justify. [2]
b) State the need for CAP theorem in the context of this application. [3]
c) How do the cloud, mobile, social and analytics components fit and integrate into this application? [4]
d) CAP theorem is specifically suitable for designing distributed applications. Justify that this application is really distributed [3]

Q.4 Set. (A) 9 Marks

On 19 February 2008, Yahoo! Inc. launched what they claimed was the world's largest Hadoop production application. The Yahoo! Search Web map is a Hadoop application that runs on a Linux cluster with more than 10,000 cores and produces data that is used in every Yahoo! web search query. There are multiple Hadoop clusters at Yahoo! and no HDFS file systems or MapReduce jobs are split across multiple data centers. Every Hadoop cluster node bootstraps the Linux image, including the Hadoop distribution. The work that the clusters perform is known to include the index calculations for the Yahoo! search engine. In June 2009, Yahoo! made the source code of its Hadoop version available to the open-source community.

In 2010, Facebook claimed that they had the largest Hadoop cluster in the world with 21 PB of storage. In June 2012, they announced the data had grown to 100 PB and later that year they announced that the data was growing by roughly half a PB per day.

As of 2013, Hadoop adoption had become widespread: more than half of the Fortune 50 companies used Hadoop.

a) What architectural pattern studied in this course is used in Hadoop? Why is this pattern relevant? [2]
b) Draw a diagram to explain this architectural pattern in the above context. [3]
c) Explain in terms of the two major components of the Hadoop system how it is relevant in this case and how the way it is used boosts the NFRs. [4]

Q.4 Set. (B) 9 Marks

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a) What architectural pattern studied in this course is used in Hadoop? Why does it perform faster than supercomputers? [2]

b) Draw a diagram to explain this architectural pattern in the above context. [3]
c) Apache Hadoop framework is composed of the following modules: Hadoop Common, Hadoop Distributed File System (HDFS), Hadoop YARN, Hadoop MapReduce, Hadoop Ozone. Explain the working on either two of these in the above context. [4]

Q.4 Set. (C) 9 Marks

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a) Hadoop handles data and processes. Identify the data and processes required for the above application. Which component handles each of these. [2]
b) Draw a diagram to explain this architectural pattern in the above context. [3]
c) Where is Name Node, Secondary Name Node, Job tracker, Data Node, Task Tracker located and what is their role in the above case. [4]

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