

Software Engineering (CS3009) Final ExamDate: June 7th 2024**Total Time: 3 Hours****Total Marks: 120****Total Questions: 07****Course Instructor(s)**

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Roll No

Section

Student Signature

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Attempt all the questions.

1. Provide answers in the sequence in which the questions and parts appear on the question paper.
 2. Avoid submitting any extra sheet(s).
- Use of a two-sided, handwritten help sheet of A-4 size is allowed. Photocopies are not allowed.
There are 3 marks for following the instructions 1 and 2.

CLO 1: Select an appropriate software development process for a software project

Q1: Draw a table on page 1 of your answer sheet. The table shall have two columns. Title of column 1 is Sr. No., title of column 2 is Answer. This table has 20 rows and each row corresponds to the respective statement given below. For each of the 20 statements given below, either **write true, false, or the missing word/phrase in the appropriate cell** on the table that you've drawn on page 1. Sometimes the choices (in round brackets) for the missing word are given with the statement. Cutting and/or overwriting is not allowed. [20 Marks]

- 1. A _____ is a series of steps that involves activities, constraints, and resources to produce an intended output.
- 2. Unit cost to fix a defect is high if the defect is fixed very late in the lifecycle.
- 3. Correctly following a good software process can reduce the costs incurred during software development. (increase/reduce)
- 4. Communication, planning, and construction are examples of Framework activities in software process. (Framework/Umbrella)
- 5. Software Quality Assurance and Risk Management are examples of Umbrella activities in software process. (Framework/Umbrella) storycards.
- 6. When using Kanban boards, _____ move from one column to another.
- 7. incementals RAD model is considered a quick adaptation of Waterfall model.
- 8. Spiral model suggests that we identify and evaluate alternatives in each iteration.
- 9. Code refactoring and continuous integration are core practices performed in Xtreme Progr. development approach.

10. If we express our project timeline using the keywords inception, elaboration, construction, and transition phases, we are following the terminology of Unified Process Model.
11. In RAD model, teams can work in parallel to provide a quick implementation of the modules which can be integrated later.
12. When we are talking about user stories, acceptance tests, spike solutions, CRC cards, we are talking about Xtreme Prog.
13. Prototyping model is the most suitable when the customer is unclear about the requirements especially the user interface related requirements and needs.
14. In scrum, a prioritized list of user requirements is named as product backlog.
15. If the core product is required very soon and the rest of the software development can continue later in steps, the most suitable model to use is incremental model.
16. A sprint, once started, cannot be broken until the end time of the sprint is reached. (True/False)
17. When compared with the conventional software processes, the cost of changing a software system using an agile process is relatively lower in long term. (lower/higher)
18. If I have to rewrite an existing software system in newer technology when the existing system is already meeting all user requirements and no new major changes in requirements are expected, I'll consider waterfall model to be the best choice to develop the system.
19. A sprint in case of scrum is not bounded by time. (True/False)
20. WIP in Kanban boards stands for work in progress.

CLO 2: Develop a model of requirements for a software system

Q2: EduLearn is an innovative company that provides personalized learning experiences to students through an online platform. The platform allows educators to upload lecture videos and assign quizzes. Based on the analysis of students' performance on these quizzes, the system suggests personalized study plans. The educators have a set of established guidelines for creating study plans which need to be embedded into the system's functionality. The main challenge is to perform the quiz analysis and generate personalized study plans efficiently so that educators can review and finalize these plans within 24 hours of the quiz submission. Ensuring high accuracy in performance analysis is another challenge; when the accuracy falls below 85%, educators need to manually adjust the study plans, which increases their workload. Additionally, the system needs to handle a large number of users simultaneously without performance degradation and have an uptime of 99.9% to ensure availability. The system should notify educators when personalized study plans are ready for review and allow them to annotate these plans. The platform must ensure that students can view the approved study plans. Furthermore, the system should provide a responsive user interface, with efficient page load times, to ensure a seamless user experience. Solve on page 2

To do: Based on the above description, **separately list 5 functional and 5 non-functional requirements** for the software system to be developed for EduLearn. All requirements should be written in standard format with hierarchical numbering. All requirements should be testable. [5+5= 10 marks]

CLO 3: Design architecture of a software system by choosing the most appropriate architecture styles

Q3: Attempt the parts in order. Solve on Page 3 and 4

Part a. The Passport department is planning to update its present architecture. Presently each authorized division keeps its own passport related data. There are 5 authorized divisions across the country. Each of these divisions is responsible for management of new passport requests, renewal of

existing passports, citizen complaints, and citizen information updates. A citizen has to visit an office for all services, for example they use kiosks in the divisional offices to record a complaint or apply for renewal etc. A citizen can request for a new passport or information updates in the passports only at his/her division of birth. The renewal requests can be placed at any office. In case of renewal requests, the passport office visited by the applicant contacts the concerned division (the division of birth of the applicant) through a coordination service running at the remote passport office (in the concerned division).

peer to peer

To do: Draw an architecture diagram expressing the present architecture of the passport office. Label the diagram completely naming the architecture styles used. The diagram should not be a general one, it should have complete detail of the parts of the system. **Justify** your choice of architecture style(s) using the text in the problem statement. The justification should not exceed 3 lines.

[7+3=10 marks]

Part b. The plan now is to move towards a different architecture where citizens benefit and the department gets more control over applications and data. The oldest division (OD) shall keep all data and control over the passport applications. The OD will be responsible for communication between the other divisional offices. The citizens do not have to visit any divisional office now and can get all the existing services remotely.

To do: Draw an architecture diagram expressing the planned architecture of the passport department. Label the diagram completely naming the architecture styles used. The diagram should not be a general one, it should have complete detail of the parts of the system. **Justify** your choice of architecture style(s) using the text in the problem statement. The justification should not exceed 3 lines.

repositories / client server [7+3=10 marks]

CLO 3: Design architecture of a software system by choosing the most appropriate architecture styles

Q4: The WebStore system is designed to facilitate seamless online shopping by integrating the key elements namely Search Engine and Shopping Cart. The Search Engine allows users to search or browse items through Product Search, which interacts with Search Inventory provided by the Inventory Management part of the Warehouses subsystem. This setup ensures accurate and up-to-date product information. The Shopping Cart leverages Manage Orders from the Orders Management part of the Accounting subsystem during the checkout process, ensuring that all transactions are processed efficiently and orders are correctly recorded. The Accounting module offers Manage Orders and Manage Customers, which are delegated to the Orders Management and Customers Management modules, respectively, ensuring robust order management and customer relationship handling. The Warehouses system's Search Inventory and Manage Inventory support these operations by maintaining the necessary product data and inventory levels, ensuring the WebStore subsystem operates smoothly and efficiently across all shopping activities.

Draw a component diagram for the above system. Solve on Page 5

[10 marks]

CLO 4: Design test cases for a software system

Q5: (For all sections EXCEPT BCS-6J)

For the following code **draw** a control flow graph, **calculate** its cyclomatic complexity, **list** independent paths, and **design test cases** using an appropriate test structure. Use the exact node numbers mentioned in the code.

[5+5+5+5= 20 Marks]

Node	Statement
(1)	while(x<100) {
(2)	if (a[x] % 2 == 0) {
(3)	parity = 0;
	}
(4)	else {
(5)	parity = 1;
(6)	}
(6)	switch(parity) {
	case 0:
(7)	println("a[" + i + "] is even");
	case 1:
(8)	println("a[" + i + "] is odd");
	default:
(9)	println("Unexpected error");
	}
(10)	x++;
(11)	}
	p = true;

Q5. (For section BCS-6J only)

The LESCO meters have an **embedded software** that keeps count of the units using a local clock. The quarter-wise peak hours and electricity rate for the whole year are as follows:

Quarter	Peak Hours	Price per unit	
		Off-peak	Peak
March 1 to May 30	10 PM to 6 PM (next day)	8	9
May 31 to August 31	11 PM to 7 PM (next day)	8	10
September 1 to November 30	10 PM to 6 PM (next day)	6.5	8.5
December 1 to February 29	9 PM to 5 PM (next day)	6	8.5

A unit consumed at 6 PM in quarter 1 will be considered a unit consumed in peak hours. The embedded software determines if a unit is consumed in peak hours or off-peak hours. Meter readers send the number of units consumed in peak and off-peak hours to LESCO office.

To do:

Identify the required input variables for test cases designed to test the embedded software. Identify the required output variable. **Design equivalence classes** for each variable, and **provide** test cases based on boundary values analysis with robustness. Use an appropriate test structure. [20 Marks]

CLO 4: Design test cases for a software system

Q6: A weather forecast application utilizes temperature (T), atmospheric pressure (P), and wind speed (S) as factors to predict the likelihood of rainfall. The temperature ranges are divided into three categories (273.15 – 288.15, 288.25 – 298.15.0, 298.25 – 323.15) in degrees kelvin, while atmospheric pressure is categorized into two ranges (0.0 – 500.0, 500.1 – 1500.0) in Hectopascal. Wind speed is segmented into three groups (0.0 – 10.0, 10.1 – 40.0, 40.1 – 90.0) in kilometers per hour. The rainfall prediction is based on predefined probabilities outlined in the following table:

T		273.15-288.15		288.25-298.15		298.25-323.15	
P		0.0-500.0	500.1-1500.0	0.0-500.0	500.1-1500.0	0.0-500.0	500.1-1500.0
S	0.0 – 10.0	10%	0%	40%	30%	70%	60%
	10.1 – 50.0	20%	10%	50%	40%	80%	70%
	50.1 – 100.0	30%	20%	60%	50%	90%	80%

To Do: Use Equivalence Class Partitioning (ECP) and Boundary Value Analysis (BVA) to determine equivalence classes for each variable and representing values for each class. Provide your answers using a tabular structure given below which will have three rows (one row for each variable):

Variable	List of Valid ECs	Representing values		List of Invalid ECs	Representing values for invalid ECs
		For valid ECs	Boundary values		

Then **design** minimum number of test cases for testing of the rainfall prediction module using ECP and an appropriate test structure. [9+8 = 17 Marks]

CLO 5: Construct reasonable sized software in team setting

Q7: (For sections A, B, C, D, E, and L only)

The Passport Department (PD) is planning a new software application for its users. The new application shall allow the employees to work from home and the citizens to get a number of services remotely. This way the PD expects a significant reduction in its operational costs. At present the system has to manage 5 big data stores which are complex. The PD has to contact the NADRA database through a moderately complex interface while processing certain citizen requests. Most of the citizen inquiries are simple in nature whereas most of the employees' inquiries are complex. As per an estimate, there are 4 types of simple citizen inquiries and 5 types of complex employee inquiries. Similarly 5 user inputs are simple, 3 moderately complex and 2 are complex. The 7 outputs are estimated to be complex in nature and 3 are simple. The information about the 14 value adjustment factors is given in the array [4 2 0 4 3 4 5 3 5 5 4 3 5 5]. For the system above:

To do:

a. Give a function points based estimate of effort and cost required to develop this application. Use appropriate units. Assume productivity and per month costs to be 7 FP/person_month and \$1000 respectively. [12 Marks]

b. Assuming that your team writes 50 source lines of code (SLOC) against a function point, calculate the estimated size of the application in terms of lines of code. Also give an estimate of effort and cost. Use the FP to SLOC mapping given in this part to calculate productivity related value. [6 Marks]

c. Compare estimates of a, b [2 Marks]

You may use the following values of complexity weight factors if required

Information Domain Value	Simple	Average/Moderate	Complex
External Inputs	3	4	6
External Outputs	4	5	7
External Inquiries	3	4	6
Internal Logical Files <u>5</u>	7	10	15
External Interface Files <u>1</u>	5	7	10

Q7: (For sections F, G, H, J and K only) Attempts the parts in order.

Part a. We as a software company have been awarded a maintenance project. Initially, we are required to determine if the continued maintenance of the software application under maintenance is affordable anymore. During this phase, our step will be to determine the cost of fixing defects by performing three activities. The first is to design and execute usage scenarios to determine if the application breaks too often during regular use. The second is to design and execute test cases to uncover faults in the application. The third is to remove the faults to see how long it takes to repair the application. The second step will be to modify existing features to determine if the cost of the changes is affordable or not. During this step, we shall modify the existing features and extend the functionality of the application by adding new features to determine the effort required to modify and add new functionality. After the first two steps, an analysis will be performed and it will be decided if the software application should remain in maintenance as before or it should be re-engineered. The first phase will run for 3 months. In the second phase, if the reengineering-related decision has been made, the foremost step of business process reengineering will be performed. This step will define the business goals, identify existing business processes, evaluate the existing processes, and create revised business processes. The second step will be the reengineering of software. This step will include activities such as inventory analysis, document restructuring, reverse engineering, program restructuring, data restructuring, and forward engineering. The third step will be to assess the quality of the resultant software and measure the maintainability of the resultant software.

Someone has told us that having a Work Breakdown Structure (WBS) will help us execute the project better. We have also been told that students at FAST Lahore are very good at making WBS to help managers of software projects. Assuming that the decision after phase 1 will be to go for reengineering, **provide a WBS** for the phases mentioned above to help our company. As an incentive, you'll be awarded good marks if the WBS helps. Use a tree-like structure to show your WBS.

Part b. A team of software engineers is working on a project following Scrum. At the start of each sprint, they select a few user stories to work on. Their selected and completed user stories in the first five sprints are as follows:

Sprint 1: The team committed to completing 8 user stories. However, the team could complete 6 of the 8 user stories. Out of those six stories, two stories had 10 story points, three stories had 5 story points, and one story had 3 story points.

Sprint 2: The team committed 10 user stories and completed 9 of the 10 user stories. Out of those nine stories, three stories had 2 story points, four stories had 6 story points, and two stories had 8 story points.

Sprint 3: The team committed 12 user stories and completed 10 of the twelve user stories. All ten user stories had 7 story points.

Sprint 4: The team committed 14 user stories and completed 12 of the 14 user stories. Out of those twelve user stories, six stories had 9 story points, four stories had 5 story points, and two stories had 3 story points.

Sprint 5: The team committed 15 user stories and completed 13 of the 15 user stories. Out of those thirteen user stories, five stories had 10 story points, four stories had 6 story points, and four stories had 2 story points.

To do:

1. **Calculate** the average sprint velocity based on how many story points are implemented in each sprint.
2. **Calculate** the total number of story points committed and the total number of story points completed for all five sprints.
3. **Give** the estimated story points the team should commit for Sprint 6