National University of Computer and Emerging Sciences, Lahore Campus

Course:	**Introduction to Software Engineering**	**Course Code:**	**SE1001**
Program:	**BS (SE)**	**Semester:**	**Spring 2022**
Duration:	**180 Minutes (3 Hours)**	**Total Marks:**	**120**
Paper Date:	**10-Jun-22**	**Weight**	**40%**
Section:	**All**	**Page(s):**	**15**
Exam:	**Final**		

Instruction/Notes:

1. Attempt all questions on the question paper. Do not submit any extra sheet, it will not be graded.
2. You are allowed to use a two-sided, hand-written, A-4 size help sheet.
3. State your assumptions clearly
4. For all the code segments in the exam, assume that all variables have been declared, all required libraries have been included, and there are no compile time errors

Name: _____ Roll Number: _____ Section _____

Question 1 (1x20 = 20 Marks)

In each of the following MCQs, **circle** the most appropriate **single** option. There are **no partial marks** in this question. Unclear answers will not be given any credit.

1) Software Engineering is best described as:
   a. the practice of designing, building, and maintaining off-the-shelf software from prefabricated parts.
   b. the practice of designing, building, and maintaining ad-hoc software without the use of formal methods.
   c. the practice of designing, building, and maintaining high-quality software in a timely and cost-effective manner.
   d. the practice of designing, building, and maintaining fast and flexible software specifically for Engineering applications.
   e. the practice of designing, building, and maintaining flashy, cheap, and buggy software engineered to generate large sales initially and an on-going market for updates.

2) Which of the following is most closely related with scrum?
   a. Use cases
   b. Stories
   c. Scenarios
   d. Sprints
   e. Bad smells

3) Pick the odd one out:
   a. Requirement gathering and documentation
   b. Analysis and design
   c. Project management
   d. Coding
   e. Testing

4) Which one of the following is an attribute of a good software test case?

   a. Has a high probability of finding an error
   b. Is not redundant
   c. Is capable of uncovering a whole class of errors
   d. Is neither too simple nor too complex
   e. Proves that the program does not have any errors
   f. All of the above except e
   g. All of the above except f

5) The incremental software development process is

   a. a reasonable approach when the product is small in size and has only one module.
   b. a good approach when a working core product is required quickly.
   c. the same as the non-incremental software development process.
   d. a revolutionary approach that is not used for commercial products.
   e. a reasonable approach when requirements are vague.

6) Maintenance may involve:

   a. only additional coding and testing.
   b. only additional analysis and design.
   c. only additional design, coding, and testing.
   d. any of the development activities except analysis.
   e. any of the development activities.

7) Which software engineering activity simplifies the design of a component without changing its function or behavior?

   a. User interface design
   b. Requirements analysis
   c. Refactoring
   d. High level design
   e. Low level design

8) Which of the following can improve understandability of a computer program?
   a. Good control structure
   b. Meaningful variable names
   c. Meaningful documentation of code
   d. All of the mentioned
9) Which of the following is an internal attribute of software quality?
   a. Performance
   b. Usability
   c. Efficiency
   d. Robustness
   e. Correctness
10) Which of the following can be attributed to the quality of software process?
   a. Interoperability
   b. Timeliness
   c. Productivity
   d. Understandability
   e. b and c only
   f. All of the mentioned

11) When estimating the effort required to engineer software, an estimate of size of the software is required. What are different ways to represent size of software (or what are units of measurement of software size)?
    a. Context diagram
    b. Function points
    c. Block diagram
    d. Lines of Code
    e. COCOMO
    f. b and d only
    g. b, d, and e only

12) Which of the following can help software engineers in software management activities?
    a. Gantt Chart
    b. PERT Chart
    c. WBS
    d. Milestones
    e. All of the mentioned
13) Which of the following help determine and achieve modularity in software?
    a. Application points, function points
    b. Uses-graph, activity graphs
    c. Coupling, cohesion
    d. Milestones, deliverables
    e. WBS, critical path
14) During engineering of software, we sometimes focus on understanding the important aspects of a phenomenon and ignore the details for a certain time. Which principle of SE do we follow if we do so?
    a. Generality
    b. Anticipation of Change
    c. Rigor and Formality
    d. Abstraction
    e. Timeliness
15) Suppose that a software application has been serving business needs for the last many years (it has obviously evolved overtime), but now its maintenance cost is getting too high. An engineer has suggested to rebuild the software application without changing its functionality and behavior. Which software engineering concept is the engineer referring to when (s)he says the application should be rebuilt?
    a. Revamping
    b. Re-engineering
    c. Refactoring
    d. Revisiting
    e. Recycling
16) Which of the following is a principle of Software Engineering Code of Ethics?
    a. Software engineers shall always produce modular design
    b. Software engineers shall be lifelong learners
    c. Software engineers shall keep generality in mind
    d. Software engineers shall work in increments
    e. Software engineers shall perform refactoring
    f. All of the mentioned
17) Pick the odd one out
    a. Keep the user busy
    b. Place the user in control
    c. Reduce user's memory load
    d. Keep user interface consistent
    e. All of the above
    f. None of the mentioned

18) Pick the odd one out
    a. Sprint
    b. Spiral
    c. Waterfall
    d. Prototyping
    e. Rapid Application Development
    f. None of the mentioned
19) Pick the odd one out
    a. Robustness
    b. Correctness
    c. Reliability
    d. Performance
    e. Modularity
    f. None of the mentioned
20) Pick the odd one out
    a. Visibility
    b. Anticipation of change
    c. Abstraction
    d. Generality
    e. None of the mentioned

Question 2 (Max. Marks = 5)

A team of software engineers is working on a project being developed using scrum. At the start of each spring they select a few user stories to work on. Assume that each user story is of 6 story points. Their selected and completed user stories in the first sprints are as follows:

Sprint 1: The team committed to complete 7 user stories (i.e. 42 story points). However, the team could complete **4** of the 7 user stories.

Sprint 2: The team committed 6 user stories (including those not completed in sprint 1) and completed **5** of the 6 user stories.

Sprint 3: The team committed 9 user stories (including those not completed in sprint 2) and completed **6** of the 9 user stories.

Sprint 4: The team committed 8 user stories (including those not completed in sprint 3) and completed **3** of the 8 user stories.

To do: Find project velocity to help the team provide a good estimate of work to be committed for sprint 5. Show your working.

Question 3 (5x2 = 10 Marks)

Answer the Following questions related to software engineering principles

a. HyperText Markup Language (HTML), Cascading Style Sheets (CSS), and JavaScript (JS) are complementary languages used in the development of web applications. **HTML** is mainly used for organization of webpage content, **CSS** is used for definition of content presentation style, and **JS** defines how the content interacts and behaves with the user.
Which principle of software engineering is being followed in development of web applications that use HTML, CSS, and JS at the same time? Explain your answer.

b. An engineer deployed 3 temperature sensors in a room and wrote following code to calculate and display the average temperature of these sensors.

```
void displayÁverage(float sensor1, float sensor2, float sensor3){

    float sum = sensor1 + sensor2 + sensor3;

    float average = sum/3;

    cout<<"The average temperature of 3 sensors is: " <<average;

}
```

Now (s)he has to deploy sensors in different **areas containing 5 rooms** and calculate the average temperature of the areas. The number of sensors in each room is not fixed, but each room has **at least 3 sensors**. (S)he comes to you with his code to make it more generalized to calculate average temperature of an area containing different number of sensors. The generalized function may be called separately for each room to get average temperature of a room. How can you modify this code to achieve **Generality?** Rewrite the code after the modification(s).

Question 4 (4x5 = 20 Marks)

Answer the Following questions related to software quality

a. A software requires its users to provide inputs and performs actions based on the input commands. A piece of C++ code has been taken from the software and is given below:

```
cout<<"Please press N to insert a new record, R to view an existing report:  ";

cin>>option;

if(option == 'N')

   insertRecord(details);

else

   showReport(details);
```

What modifications can be made to improve **Robustness** of the software? Rewrite the code after the modification(s).

b. Consider the following function written in C++:

```
int f(int a, int b){

   int c = a + b;

   return c;

}
```

What modifications can be made to improve **Readability** of the software code? Rewrite the code after the modification(s)

c. Consider an Operating System (OS) which is monolithic (one big unit) in nature. Revisiting its design might help us divide the OS into modules and improve the design. If the design is not improved and the OS is kept monolithic, which software quality attribute(s) is/are difficult to achieve? Why?

Hint: Consider the users of Microsoft Windows having problems using the Windows for example.

d. Software is considered **Reliable** if there is a high probability that the software will operate as expected over a specified period of time. A software system is **Repairable** if its defects can be corrected with a reasonable amount of work (i.e. errors can be located and corrected more easily). How does **Repairability** of a software product affect **Reliability** of the software product? Answer in terms of increase or decrease in reliability if the software has good repairability.

e. **Dangling pointers** keep pointing to a memory location that has already been deallocated in a program. A **Memory leak** is when a program does not deallocate the memory when the memory is not needed anymore or the program is no longer able to access a memory location (which has not been properly deallocated). If a software has dangling pointers in it and memory leaks related issues are also found in the software, which **quality attribute of software** seems to have been compromised or affected? Explain your answer.

Question 5 (5x5 = 25Marks)

List the process model that you think will be most appropriate for the following situations. Also, list your reason(s) for choosing a particular model. If you just list the process model without mentioning the reason(s), you will not be awarded any marks.

a. You have been appointed a project manager within an information systems organization. Your job is to build an application that is quite similar to others your team has built, although this one is a larger, complex, and an ongoing project. Requirements have been thoroughly documented by the customer but requirements can be changed with respect to time. Due to complexity and change in requirements there exist high chances of failure and risk. Due to the risk and chances of failure the client is willing to communicate very frequently (even on hourly basis) for possible feedback.

   Process Model: _____
   Reason(s):

b. You have been asked to develop a small application that analyzes each course offered by a university and reports the average grade obtained in the course (for a given term). You have good understanding of requirements about the project, and no one from the university will interrupt and give any kind of feedback in near future.

   Process Model: _____
   Reason(s):

c. You have been asked to develop an E-Commerce Website. Your client is not pretty much sure about all the features. (S)he is willing to provide some initial requirements and will provide continuous feedback to refine the design. The frequency of feedback can be either once or twice a month only.

   Process Model: _____
   Reason(s):

d. You have been appointed a project manager for a major software products company that has ample human resources available for multiple software projects. Your job is to manage the development of the next generation version of its widely used word-processing software. Because competition is intense, tight deadlines have been established and announced. This software is already developed with a good modularization approach. Already available resources can be deployed to this project anytime.

Process Model: _____
Reason(s):

e. GolfLabs is a dynamic company which allows golf coaches to analyze golf swings of players and advise the players based on the analysis. The coaches have mature rules for swing analysis and the rules are very less probable to change. GolfLabs needs to develop a software system that supports the coaches during analysis by processing players' videos. You already understand their problem and know the video processing libraries that can help the development. GolfLabs wants you to develop the software in next few months and show them the mature version of the running software when it is ready after proper testing.

Process Model: _____
Reason(s):

Question 6 (10 Marks)

Following is the code to reduce a fraction. Rewrite the following code using functions to improve modularity such that a function named "reduce" takes two positive integer arguments, namely "numerator" and "denominator" and returns the reduced fraction. Use the next page to answer this question.

```
#include <iostream>
using namespace std;
int main()
{
	int num1 =0, num2 = 0, flag=0;
	int gcd = 0,temp1,temp2;
	char choose='y';
	do
	{
		cout << "Enter first number: ";
		cin >> num1;
		cout << "Enter second number: ";
		cin >> num2;
		gcd = 0,temp1=num1,temp2=num2;
		if (num1 <= 0 || num2 <= 0)
		{
			flag=0;
		}
		else
		{
			while (temp1 % temp2 > 0)
			{
				gcd = temp1 % temp2;
				temp1 = temp2;
				temp2 = gcd;
			}
			num1 = num1 / gcd;
			num2 = num2 / gcd;
			flag=1;
		}
		if (flag)
		{
			cout << "The maximum reduction possible is: ";
			cout << num1 << "/" << num2 << endl;
		}
		else
		{
			cout << "Fraction Error" << endl;;
		}
		cout<<"Press Y if you want to Continue?"<<endl;
		cin>>choose;
	}while(choose=='y'|| choose=='Y');

	return 0;
}
```

Question 7 (10 Marks)

We as a software company have 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 we shall design and execute usage scenarios to determine if the application breaks too often during the regular use. We shall design and execute test cases to uncover faults in the application. We plan to remove the faults to see how long does it take to repair the application. We shall also modify existing features to determine if the cost of the changes is affordable or not. We shall extend the functionality of the application by adding new features to determine the effort required to add new functionality. After all these activities, an analysis will be performed and it will be decided if the software application should remain in maintenance as before or it should be reengineered. This phase will run for 3 months. In the second phase, if reengineering related decision has been made, the foremost step of business process reengineering will be performed. This step will define the business goals, identifies existing business processes, evaluate the existing processes, and create revised business processes. The second step will be reengineering of software. This step will include activities such as inventory analysis, document restructuring, reverse engineering, program restructuring, data restructuring, and forward engineering. This step will also include the activity of controlling versions of the programs. The third step will be to assess quality of the resultant software and measure 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 SE 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, develop a WBS for the phases mentioned above to help our company. As an incentive you'll be awarded good marks if the WBS helped. Use tree-like structure to show your WBS.

[For Question 7 Solution]

Question 8 (20 Marks)

For a software engineering project, following activities are to be carried out. Their relationship with other activities and expected durations (in days) are mentioned in table below. Draw the activity network diagram (aka activity on node graph) for the activities mentioned in the table. Use the appropriate node structure. Determine and explicitly mention the minimum time required to complete the project (use appropriate units). For each node, also mention the earliest start, earliest finish, latest start, latest finish, and slack. Clearly specify/highlight the critical path and critical activities.

Activity	Description	Duration	Predecessor
START	Kick-off meeting		
A	Planning	24	START
B	Wireframes	16	A
C	Wireframe Approval	24	B
D	Design	20	C
E	Design Approval	24	D
F	Content Development	48	E
G	Back-End Development	60	E
H	Front-End Development	40	E
I	Content Import	8	F, G, H
J	Testing	32	G, H
K	Review	40	I, J
L	Launch	4	K
END			L

[For Question 8 Solution]