National University of Computer and Emerging Sciences, Lahore Campus

Course:	**Software Engineering**	Course Code:	CS303
Program:	**BS (CS)**	Semester:	**Fall 2018**
Duration:	**180 Minutes (3 Hours)**	Total Marks:	85
Paper Date:	**24-Dec-18**	Weight	40%
Section:	**ALL**	Page(s):	12
Exam:	**Final**		

Instruction/Notes:

1. A double-sided, hand-written, A4-size help sheet is allowed.

2. Attempt all questions on the question paper. Neither use nor submit any extra sheet.

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Question 1 (Max. Marks = 20)

In each of the following MCQs, **circle** the most appropriate **single** option. 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 eXtreme Programming (XP)?

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. <mark>Project management</mark>
    d. Coding
    e. Testing

4) Which one of the following is NOT a constituent component of software architecture?

    a. Set of components that perform required system functions.
    b. Set of connectors allowing communications among the components.
    c. Constraints describing how the components maybe integrated to form a system.
    d. <mark>Test plans for testing the architecture.</mark>
    e. Semantic models that enable the designer to understand the overall system properties by analyzing the known properties of its components.

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5) Which one of the following is NOT an attribute of a good software test?

    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. <mark>Proves that the program does not have any errors</mark>

6) Which of the following statements is NOT true?

    a. A good design methodology should provide a clear division of design from implementation.
    b. A good design methodology should not promote a top-down decomposition strategy.
    c. <mark>A good design methodology should always encourage phased development of the software.</mark>
    d. A good design methodology should help to minimize future maintenance.
    e. A good design methodology should encourage encapsulation.

7) Which of the following documents would be needed before the other documents mentioned below can be developed?

    a. Detailed project plan
    b. Design specification
    c. Test Plan
    d. <mark>Software requirements specification</mark>
    e. Implementation plan

8) Validation is concerned with the following:

    a. <mark>Are we building the right product?</mark>
    b. Are we building the product right?
    c. Does the product comply with its design?
    d. Can the proof of the correctness be formalized?
    e. Has the product been completely tested?

9) Which of the following statements is most probable from the diagram given below?

a. A, B, C and D are loosely coupled components
b. A and B are more coupled than C and D
c. A and B are more cohesive than C and D
d. C and D are more coupled than A and B
e. C and D are more cohesive than A and B

A	B

C	Shared Data	D
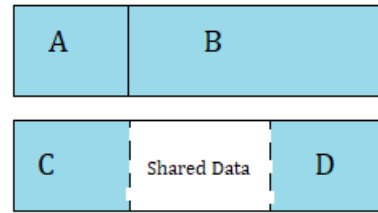
10) Beta testing

a. is also known as 'acceptance testing'.
b. is the same as integration testing.
c. requires that the system is given for real use to a number of potential users to detect errors.
d. is repeatedly done until the system is error free.
e. is carried out by the development organization.

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11) Which of the following statements about software process is NOT true?

    a. The process covers all steps from initial idea and requirements to delivery, maintenance, and final retirement.
    b. Having a good process guarantees that you will have a good product.
    c. Different processes are needed for different kinds of software.
    d. The process is the key factor in determining key properties or qualities of the product.
    e. The process is a key factor in ensuring conformance to the established practices.

12) Which of the following would be least appropriate to include in a requirements document?

    a. Environment requirements
    b. An architectural diagram
    c. Design and implementation constraints
    d. A description of how the potential users do their work without the proposed system
    e. Performance requirements

13) 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 iterative software development process.
    d. a revolutionary approach that is not used for commercial products.
    e. a reasonable approach when requirements are vague.

14) If each part of a component is necessary for the execution of a single task, then

    a. the component has layered cohesion.
    b. the component has functional cohesion.
    c. the component has functional coupling.
    d. the parts of the component are not related but simply placed in a single component.
    e. the modifications related to this component will be complicated.

15) In a data-flow diagram (DFD),

    a) there is only one bubble at level 0.
    b) at level 0, the number of processes are the same as number of verbs given in the problem description.
    c) data flow need not be balanced across consecutive DFD levels.
    d) every bubble must be refined to at least 5 bubbles in the next level.
    e) the external entities are always humans.

16) What information is provided by functional requirements?

    X1:   The constraints on the services or functions offered by the system such as timing constraints.

    X2:   How the system should behave in particular situations.

    X3:   The constraints on the development process, standards.

    X4:   How the system should react to particular inputs.

    a) X2, X4
    b) X1, X2, X4
    c) X4
    d) X1, X3
    e) X2

17) Which of the following statements is NOT true?

    a) Requirements must be testable.
    b) Requirements must be concerned with system functionality only.
    c) Requirements must be complete.
    d) Requirements must be unambiguously stated.
    e) Requirements must be consistent.

18) Which of the following are **generic** phases of software development life cycle (SDLC)?

    a) modeling, construction, deployment
    b) what, how, where
    c) programming, debugging, maintenance
    d) analysis, design, testing
    e) OOA, OOD, OOP

19) Errors introduced in which activity are most costly to fix during acceptance testing?

    a) Requirements gathering
    b) Design
    c) Coding
    d) Unit testing
    e) Integration testing

20) 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.

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Question 2 (Max. Marks = 20 = 5 + 5 + 10)

Use the information given below to answer the following questions.

New Bank of Pakistan (NBP) needs a banking application that allows its customers to maintain their bank accounts. This application should allow the customers to view account balance, pay utility bills, transfer funds, and shop online using the bank account number. NBP expects that, once the application is developed, its customers can login using their valid unique account number and a valid password. NBP does not want to get into a situation where account details including the passwords are leaked to unwanted entities during data transmission as well as data storage. An NBP customer cannot create his/her account. Only Admin, residing in Head Office of NBP, creates account of a new customer. The customer, however, enters his/her details into the application and sends the account creation request to Branch Manager. The Branch Manager verifies the customer details and forwards each verified request to Admin through the same banking application before the end of the day. The Admin creates an account on recommendation of the Branch Manager. Admin must ask the customers to verify their emails before end of the next working day. Account creation will be successful only if a customer verifies his/her email address by using the link sent during account creation process. Once the email is verified, the Admin creates the account and provides the customer with a unique login id through the verified email. The password is generated once account creation is successful, but the password is not shared through the banking application. In addition, the Branch Manager is notified about the success of the account creation process. In case the account creation process is not successful, the Admin rejects the request and the Branch Manager is notified about the rejection. The customer must change the password at first login and password must follow a strict password policy. NBP also expects that their customers can perform internet banking swiftly. Specifically, Bill Payment should be processed instantly. Novice users should be able to transfer funds after reading the user manual once. Furthermore, the account balance shall reflect each funds transfer transaction within 5 seconds of request.

a. List **all** functional requirements of the banking application that are <u>directly related to the Branch Manager</u>. All of these requirements should be testable/verifiable.
   1. The banking application shall provide the Branch Manager with a list of account creation requests submitted by the customers.
   2. The banking application shall show the Branch Manager deadline for each of the account creation requests.
   3. The banking application shall show a particular account creation request to the Branch Manager.
   4. The banking application shall allow the Branch Manager to send verified account creation requests to Admin for final decision (Accept/Reject).

5. The banking application shall show the Branch Manager a list of notifications about successful/unsuccessful account creation requests.

b. List 5 non-functional requirements for the banking application. All of these requirements should be testable/verifiable.
   1. The banking application shall store the password in encrypted format.
   2. The banking application shall ensure secure transfer of login data (that includes password) and always transfer passwords in encrypted format.
   3. The banking application shall perform authentication at the time of login.
   4. The banking application shall process the Funds Transfer within 5 seconds of request.
   5. The banking application shall be easy to use and novice users shall be able to transfer funds after reading the user manual once.

c. Consider the following list of requirements for the banking application discussed above. Restricting yourself to the problem statement given above, label each requirement as Relevant (R), Not Relevant (NR), Testable (T), Not Testable (NT) by placing tick/check marks in the appropriate cells against each requirement:

Sr.	Requirement	R	NR	T	NT
1	NBP customers shall be able to perform internet banking swiftly.	1			1
2	Bill Payment shall be processed instantly.	1			1

3	The banking application shall allow the customers to maintain their bank accounts.	1			1
4	The banking application shall provide the Admin a list of account creation requests forwarded by the Branch Manager.	1		1	
5	The banking application shall allow the customers to retrieve forgotten passwords.		1	1	

Question 3 (Max. Marks = 15 = 6 + 5 + 4)

Use the information given below to answer the following questions.

My Cute Bank (MCB) has approximately 1500 branches all over Pakistan that use a computerized MCB banking system for daily banking activities. The branches are connected with their Head Office (HO) in Karachi and communicate with the HO at least twice a day. At start of each working day every branch has to mark start of the day through the computerized banking system and update its record from the HO to make the branch's records consistent with the records at the HO. Similarly, at the end of each working day every branch has to mark end of day. At end of day every branch sends complete information regarding the day's transactions to the HO and the HO updates its records related to customer accounts and the branch's status. Normally, the branches and the HO do not necessarily need to communicate with each other through the computerized banking system from start of the day to end of the day.

Approximately 80% branches have ATMs connected with them which accept MCB ATM cards only. During a day, ATM transactions on a machine connected with a branch are managed by the branch. During each ATM transaction, the branch contacts all other branches to determine the total amount of cash withdrawn in this day against a particular ATM card. This information is used to approve or disapprove a particular user request for cash withdrawal when the daily limit is exceeded for a particular card.

The HO also keeps record of branches that have or have not updated themselves at 8:55 AM on each working day. Using the computerized banking system a Support Engineer at the HO sends a message to Branch Manager if the manager's branch has not updated itself till 8:55 AM on a working day.

   a. Identify the three subsystems of the MCB computerized banking system in the boxes given below and, in each box, list all modules needed in that subsystem.

Subsystem 1: _____	Subsystem 2: _____	Subsystem 3: _____1

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b. Assume that MCB banking system is currently operational in the following cities only: Karachi, Lahore, Peshawar, Quetta, Islamabad, Faisalabad, and Haiderabad. There is only one branch of MCB in each of these cities including Karachi. In addition, head office of MCB is located in Karachi. All branches except Haiderabad and Faisalabad branches have ATM machines attached with them.

Draw, using boxes and arrows, the architecture diagram for the given scenario (in part b) using the relevant information in the problem statement as well as in part b. While drawing this diagram, use all suitable architectural styles.

c. Give a comma separated list of all the architectural styles used in diagram of part b. Give a brief justification for using each architectural style.

Architectural styles used: _____

Justification:

Question 4 (Max. Marks = 10 = 8 + 2)

<table>
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```
1. void multiply(int a[10][10], int b[10][10], int r1, int c1, int r
2. {
3.    int mult[10][10], i, j, k;
4.
5.    // Initializing elements of matrix mult to 0.
6.    for(i = 0; i < r1; ++i)
7.       for(j = 0; j < c2; ++j)
8.       {
9.          mult[i][j]=0;
10.      }
11.   // Multiplying matrix a and b and storing in array mult.
12.   for(i = 0; i < r1; ++i)
13.      for(j = 0; j < c2; ++j)
14.         for(k = 0; k < c1; ++k)
15.         {
16.            mult[i][j] += a[i][k] * b[k][j];
17.         }
18.   // Displaying the multiplication of two matrix.
19.   cout << endl << "Output Matrix: " << endl;
20.   for(i = 0; i < r1; ++i)
21.   for(j = 0; j < c2; ++j)
22.   {
23.      cout << " " << mult[i][j];
24.      if(j == c2-1)
25.         cout << endl;
26.   }
27.   cout << endl;
28. }
```

</td><td>

Flow Graph

</td></tr>
</table>

The C++ function given above [Adapted from: https://www.programiz.com/cpp-programming/examples/matrix-multiplication] is used for multiplying two matrices (a and b). Note that line numbers have been added at the start of each line of code for convenience.

a. Draw the flow graph of this function inside the box appearing besides its code. Nodes must be annotated clearly on the code.

b. What is the maximum number of linearly independent paths in the flow graph of this function?

Maximum number of linearly independent paths = V(G)

V(G) = R =

V(G) = P + 1 =

V(G) = E - N + 2 =

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Question 5 (Max. Marks = 20 = 10 + 10)

An economics application estimates the human poverty index (HPI) of a country by considering its GDP in billions of US dollars (0.0 – 100.0, 100.0+), its unemployment rate (UR) as a percentage (0.0 – 10.0, 10.1 – 50.0, 50.1 – 100.0), its inflation rate (IR) (low, high), and its average family size (AFS) (very small, small, medium, large, very large). The HPI estimation module of this application uses the estimates shown in the table below.

GDP		0.0 – 100.0						100.0+					
UR		0.0 – 10.0		10.1 – 50.0		50.1 – 100.0		0.0 – 10.0		10.1 – 50.0		50.1 – 100.0	
IR		low	high	low	high	low	high	low	high	low	high	low	high
AFS	very small	14.5	13.5	15.5	15.0	14.0	16.0	10.0	11.0	11.5	12.5	12	13
	small	15.5	14.5	16.5	16.0	15.0	17.0	11.0	12.0	12.5	13.5	13	14
	medium	16.5	15.5	17.5	17.0	16.0	18.0	12.0	13.0	13.5	14.5	14	15
	large	17.5	16.5	18.5	18.0	17.0	19.0	13.0	14.0	14.5	15.5	15	16
	very large	18.5	17.5	19.5	19.0	18.0	20.0	14.0	15.0	15.5	16.5	16	17

Use ECP and BVA to fill out the following two tables for black-box testing of the HPI estimation module. Use **minimum** test cases in the last table.

Variable	Valid ECs	Representing values		Invalid ECs	Representing values for invalid ECs
		For valid ECs	**Boundary values**		
GDP	(1) 0.0 – 100.0 (2) 100.0+	50.0 150.0	0.0, 100.0 100.1	(1) Any alpha-numeric value (not GDP)	ABC
UR	(1) 0.0 – 10.0 (2) 10.1 – 50.0 (3) 50.1 – 100.0	5.0 30.0 70.0	0.0, 10.0 10.1, 50.0 50.1, 100.0	(1) Values > 100.0 (2) Any alpha-numeric value (not UR)	150.0 DEF
IR	(1) low (2) high	low high		(1) Values other than low or high	medium
AFS	(1) very small (2) small (3) medium (4) large	very small small medium large		(1) Values other than very small, small, medium, large, or very	extra large

	(5) very large	very large		large	

Test case type	Test case no.	GDP	UR	IR	AFS	Test case results (HPI)
For valid ECs	1	50.0	5.0	low	very small	14.5
	2	150.0	30.0	high	small	13.5
	3	50.0	70.0	low	medium	16.0
	4	50.0	5.0	low	large	17.5
	5	50.0	5.0	low	very large	18.5
	6	0.0	0.0	low	very small	14.5
	7	100.0	10.0	low	very small	14.5
	8	100.1	10.1	low	very small	11.5
	9	0.0	50.0	low	very small	15.5
	10	0.0	50.1	low	very small	14.0
	11	0.0	100.0	low	very small	14.0
For invalid ECs	12	ABC	5.0	low	very small	Invalid GDP
	13	50.0	150.0	low	very small	Invalid UR
	14	50.0	DEF	low	very small	Invalid UR
	15	50.0	5.0	medium	very small	Invalid IR
	16	50.0	5.0	low	extra large	Invalid AFS

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