National University of Computer and Emerging Sciences, Lahore Campus

Course Name:	Software Quality Engineering	Course Code:	SE 3002
Degree Program:	BS (SE)	Semester:	Fall 2023
Exam Duration:	60 Minutes	Total Marks:	45
Paper Date:	02-Oct-2023	Weight	15%
Section:	ALL	Page(s):	5
Exam Type:	Midterm-I		

Student : Name: Solution Roll No. _____ Section: _____

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 single-sided, hand-written, A-4 size help sheet. Colored or black & white photocopies are not allowed.
3. State your assumptions clearly

Question 1 (Max. Marks = 6+4 =10)

Your company is developing an online banking system. The system should allow customers to perform a variety of tasks such as viewing their account balance, transferring funds, paying bills, and viewing transaction history. The system should provide services 24/7, be able to handle high traffic during peak times, and ensure high security to protect customers' sensitive information.

a. Explain the 3 most relevant Quality Attributes/Characteristics in context of the given requirements for this system. Justify your choices

- Security
  * mentioned in the last sentence. This is a banking app and data protection is considered very important in such apps
- Reliability
  * in order to provide 24/7 services the system should have high MTBF value.
- Performance
  * the system shall handle high traffic

any 3

- Availability : 24/7 services are required.

b. Design 4 black box test cases for the banking system using the appropriate test case structure and input values.

- Appropriate test case structure. (Test Design & unfilled I/O, Result columns)
- Relevant test cases

0024

Question 2 (Max. Marks = 5)

During development of a software product our company conducts inspections and reviews to discover defects at different stages of development. An inspection I_0 of requirements artifacts of product p' discovered 160 defects which were removed immediately before the start of design phase. Another inspection I_1 later captured 400 defects out of which 40 were due to requirements artifacts. Calculate **defect removal effectiveness** of requirements phase only.

Defects removed during requirements = 160

Requirements related defects found later = 40

$$DRE = \frac{160}{40+160} = \frac{160}{200} = 80\%$$

Question 3 (Max. Marks = 5)

Consider the software maintenance related metric fix response time metric Mean Time to Problem Closure (MTPC). Suppose a company has a system in place and the following data is taken from the bug reporting and management system:

Sr.	Reported Problem	Problem open time	Problem closing time	Time taken
1	Problem X	2023-05-10 9:40 AM	2023-05-10 4:40 PM	7 hours
2	Problem Y	2023-05-11 12:40 PM	2023-05-12 2:10 PM	6 hrs 30 min
3	Problem Z	2023-05-11 10:30 AM	2023-05-11 2:30 PM	4 hrs
4	Problem A	2023-05-11 11:00 AM	2023-05-11 4:00 PM	5 hrs

Assume that one day is 8 hours long (9 AM to 5 PM) and only the working hours are counted when calculating the values for MTPC.

a. Calculate the MTPC for the above data.

$\frac{7+6.5+4+5}{4} = \frac{25.5}{4} \simeq$ ~~6.5 hrs~~ 6.37 hrs $\simeq$ 6 hrs 22 minutes 20 seconds

~~6 hrs 37 minutes~~

b. Comment if the fix response time of the company is good or bad. Also give reasons.

Depends on the SLA, if the ~~req~~ prescribed ~~MTTR~~ value is 8 hrs then it's good

if " " " 4 hrs " " bad

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Question 4 (Max. Marks = 5)

A company has recently shipped Release$_i$ of a software product p. In Release$_i$, 18000 New Code Instructions (NCI) have been added. During development of Release$_i$ no existing SSI have been deleted however 4000 existing lines have been modified. During the testing of Release$_i$, 2000 errors were discovered in the newly added and recently modified code. Determine **defect density** for the newly added and modified code **only**. Use and mention appropriate units.

Note: SSI = Shipped Source Instructions and is defined as follows:
$SSI_i = SSI_{i-1} + NCI_i$ – deleted code in release$_i$

NCI = 18000 LOC
Modified code = 4000 LOC
Errors = 2000

Size of the release for which the density is to be calculated
= 18000 + 4000
= 22000 LOC (SI)

Defect Density = $\frac{2000}{22000}$ = 1/11 defects per LOC or SI = 0.0909 defects per SI
= 90.9 ≈ 91 defects per KLOC or KSI

Question 5 (Max. Marks = 6+4 = 10)

Consider the project data available in the following project table. The project started on Day 1 and had only 5 tasks, pd stands for person days:

Task	Planned Completion Day	Actual Completion Day	Estimated Effort	Actual Effort Expended
Task 1	Day 2	Day 2	2 pd	3 pd
Task 2	Day 3	Day 4	2 pd	5 pd
Task 3	Day 4	Day 4	1 pd	3 pd
Task 4	Day 4	Day 6	3 pd	6 pd
Task 5	Day 5	Day 7	4 pd	7 pd
			12 pd	24 pd Total

a. Calculate the following metrics for the above project data (the 5 tasks were expected to get completed on day 5 but actually got completed on day 7), show all steps.

i. $Schedule\ Estimation\ Accuracy\ (SEA) = \frac{Actual\ total\ project\ duration}{Estimated\ total\ project\ duration}$ → 7 days → 5 days

$SEA = \frac{7}{5} = 1.4$ (ie. underestimated)

ii. $Effort\ Estimation\ Accuracy\ (EEA) = \frac{Actual\ total\ project\ effort}{Estimated\ total\ project\ effort}$ → 24 pd → 12 pd

$$EEA = \frac{24}{12} = 2$$

b. Keeping in mind the estimation accuracies of part a, provide the planned completion day for task 6 given that its originally estimated effort is 2 pd, it can start after completion of task 5 only and it has only one human resource working on it.

original estimated effort = 2 pd.

original planned completion day = Day 7.

Adjusted estimate of effort based on EEA:

= original estimated effort × EEA

= 2 × 2 = 4 pd.

Adjusted planned completion day

= 7 × 1.4

~ Day 9.

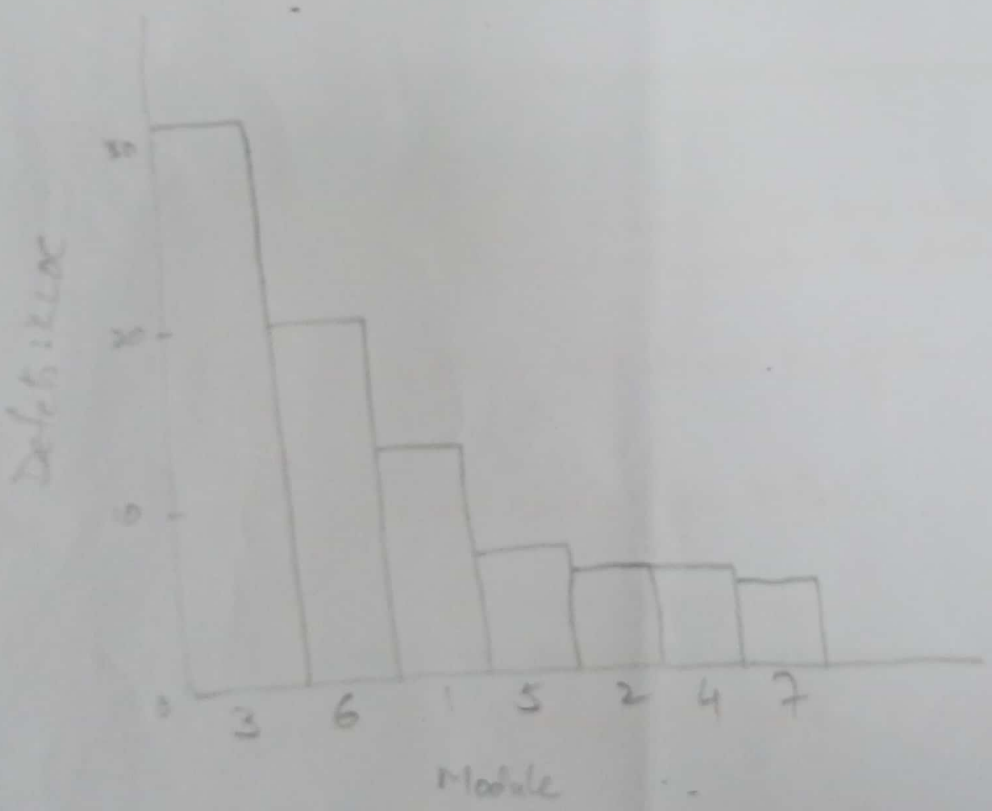
Question 6 (Max. Marks = 7+3 = 10)

Consider the following table about a software project:

Module	LOC: PH	LOC: IH	LOC: TH	Defects: TH	Defects: KLOC	PH: IH
1	160	170	85	1.5	13	1.5
2	145	345	105	0.5	5	2.5
3	105	50	35	1	31	2.5
4	765	790	390	2	5	1
5	100	150	60	0.5	6.5	1.5
6	195	255	110	2.5	19.5	1.5
7	550	525	270	1.5	4.5	1

LOC: Lines of Code, PH: preparation hours, IH: inspection hours, TH: total hours

Consider the above table and draw Pareto diagram for the column (Defects:KLOC) to know the modules that cause the higher number of defects. Label the chart completely. Comment which three modules need more attention to reduce the defect density.



Modules 3, 6, 1 need more attention

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Course Name:	Software Quality Engineering	Course Code:	SE 3002
Degree Program:	BS (SE)	Semester:	Fall 2023
Exam Duration:	60 Minutes	Total Marks:	60
Paper Date:	11.11.2023	Weight	15%
Section:	All	Page(s):	6
Exam Type:	Midterm-II		

Student : Name: Solution Roll No. _____ Section: _____

Instruction/ Notes:
1. Attempt all questions on the question paper. Do not submit any extra sheet, it will not be graded.
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Question 1 (Max. Marks = 10+10 = 20) CLO 4

An online financial aid processing application of a private university determines the tuition waiver given to a student by looking at the income class of the student's family (H = High, A = Average, L = Low), the gender of the student (M = Male, F = Female), and the CGPA of the student (0.0 – 2.0, 2.1 – 3.0, 3.1 – 4.0). The tuition waiver calculation module of this application uses the tuition waiver percentages shown in the table below.

Income Class		H		A		L	
Gender		M	F	M	F	M	F
CGPA	*0.0 – 2.0*	0	10	10	20	20	30
	2.1 – 3.0	10	20	20	30	30	40
	3.1 – 4.0	20	30	30	40	40	50

A. Fill out the following table with information about equivalence classes (ECs) for the tuition waiver calculation module.

Variable	Valid ECs	Representing values		Invalid ECs	Representing values for invalid ECs
		For valid ECs	On Boundary values		
Income Class	i) High ii) Avg. iii) Low	i) H ii) A iii) L	– – –	Any other value	X, 1, $
Gender	i) Male ii) Female	i) M ii) F	– – –	Any other value	A, J, K, 9, &
CGPA	0.0 ≤ CGPA ≤ 2.0 i) CGPA between 0 & 2 ii) 2.1 ≤ CGPA ≤ 3.0 iii) 3.1 < CGPA ≤ 4.0	1.5 2.4 3.7	0.0 & 2.0 2.1 & 3.0 3.1 & 4.0	i) CGPA < 0.0 ii) 4.0 < CGPA	-0.9 -4.2

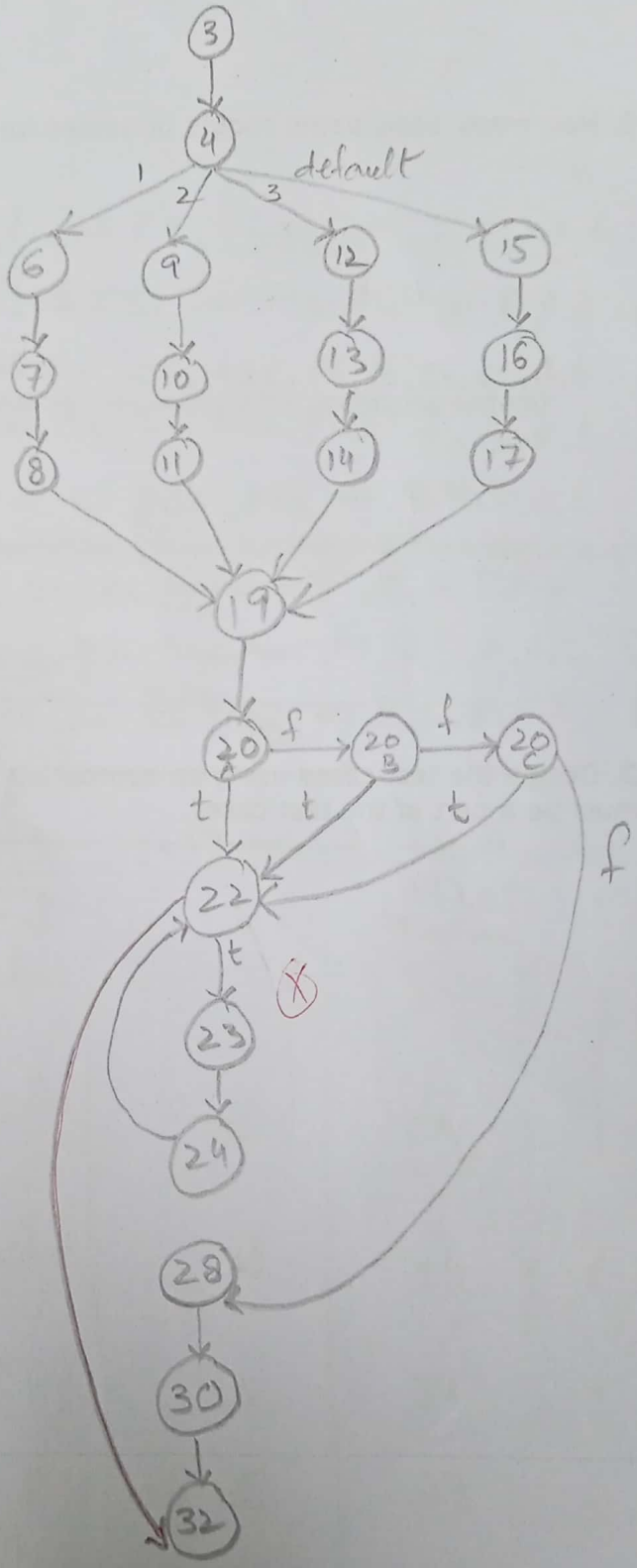
B. Fill out the following table with information about test cases for the tuition waiver calculation mo
Equivalence Class Testing and design **minimum** test cases in the following table. Add more rows if required.

Test case type	Test case no.	Income Class	Gender	CGPA	Expected Output (Waiver percentage)
For valid ECs	1	H	M	1.5	0
	2	A	F	2.4	30
	3	L	M	3.7	40
For invalid ECs	4	X	M	1.5	
	5	A	J	3.7	
	6	H	M	-0.9	
	7	L	F	4.2	

Question 2 (Max. Marks = 5 + 5 + 5 + 5 = 20) CLO 4 0100

A. Draw the control flow graph (CFG) of **foo** given below. Draw the CFG in the space available besides the box with the code. Decision Nodes must be annotated clearly. [Note: Line numbers have been added at the start of each line of code for convenience, use these numbers only]

```
1 int foo (int a)
2 {
3   int b=0;
4   switch(a)
5   {
6     case 1:
7       b=a;
8       break;
9     case 2:
10      b=(a/2);
11      break;
12    case 3:
13      b=(a/3);
14      break;
15    default:
16      b=0;
17      break;
18  }
19  int c = 0;
20  if (b==a || b==0 || a==0)
21  {
22    while (c != 10)
23    {
24      a+=c;
25      c++;
26    }
27  }
28  else
29  {
30    c=(b+10);
31  }
32  return (a+b+c);
33 }
```



N=24 , E=30

B. Find cyclomatic complexity for the CFG of **foo**? Show complete working.

CC : E - N + 2

= 30 - 24 + 2

= 8

C. How many basis paths should be tested for **foo**? List all the basis paths for the CFG drawn in part A.

8

P1: 3, 4, 6, 7, 8, 19, 20A, 22, 23, 24, 25, 26, 22, 32

P2: 3, 4, 9, 10, 11, 19, 20A, 22, 23, 24, 25,26, 22, 32

P3: 3, 4, 12, 13, 14, 19, 20A, 22, 23, 24, 25,26, 22, 32

P4: 3, 4, 15, 16, 17, 19, 20A, 22, 23, 24, 25,26, 22, 32

P5: 3, 4, 15, 16, 17, 19, 20A, 20B, 22, 23, 24, 25,26, 22, 32 (chosen P4 on purpose)

P6: 3, 4, 9, 10, 11, 19, 20A, 20B, 20C, 28, 30, 32 (chosen P2 on purpose)

P7: 3, 4, 6, 7, 8, 19, 20A, 20B, 20C, 22, 32

P8: 3, 4, 6, 7, 8, 19, 20A, 20B, 20C, 22, 23, 24, 22, 32

D. Design the test cases using an appropriate structure for the basis paths listed in part C. Input data must be a part of the test cases.

TID	Purpose	Input (a)	EO (Return Value)
1	Test P1, Sensitize P1	1	57
2	P2	—	infeasible path. (if at line 20 is false)
3	P3	—	infeasible path. (4)
4	P4	—	infeasible path
5	P5	4	63
6	P6	2	14
7	P7	—	infeasible path
8	P8	—	infeasible path

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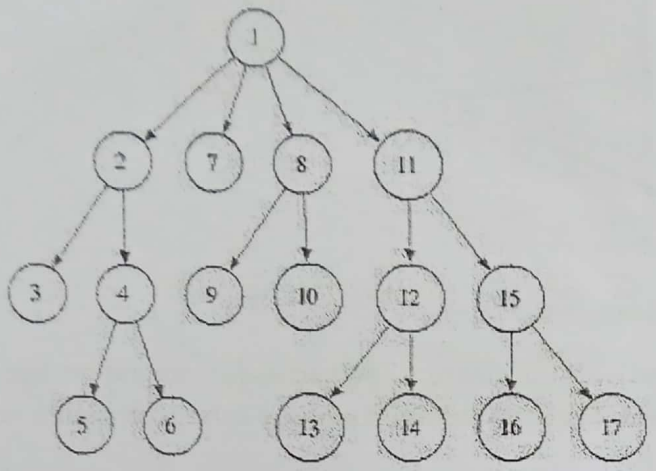
Question 3 (Max. Marks = 1+1+2+2+2 = 8) CLO 4

Consider the following call graph for a system:



A. How many testing sessions are required if we perform pairwise integration of the underlying system?

16 OR E

B. How many testing sessions are required if we perform neighborhood based integration of the underlying system?

7 i.e. N-Sink

C. Write the nodes in neighborhood of 11: {1, 12, 15}

D. Write the nodes in neighborhood of 1: {2, 7, 8, 11}

E. Write the nodes in neighborhood of 13: {12}

Question 4 (Max. Marks = 12) CLO 4

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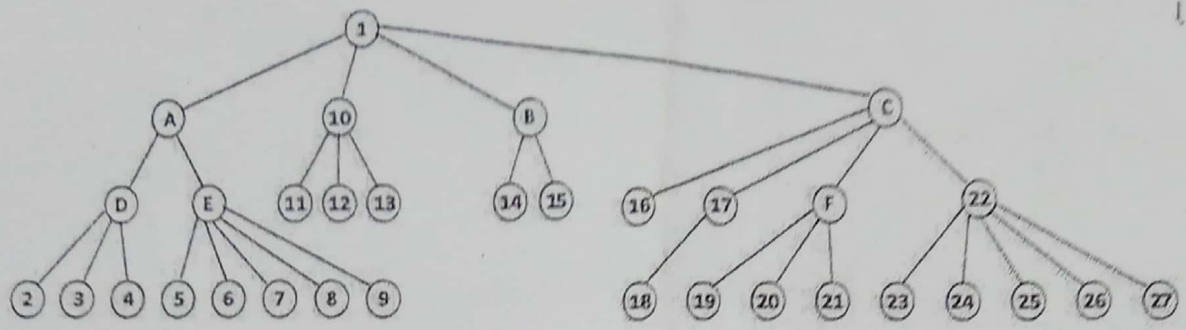
Consider the following functional decomposition of SATM System:



How many stubs, drivers, and testing sessions are required is we use different approaches for integration. Use the following table to solve this part. Do not leave any cell blank. **Explicitly write N/A** where a certain concept is not applicable:

Integration Approach	Stubs	Drivers	Test Sessions
Big Bang	N/A	N/A	1
Top-Down	33-1 = 32 nodes-1	N/A	10 + 32 = 42 nonleaves + edges
Bottom-Up	N/A	10 non leaves	10 + 32 = 42
Pairwise	N/A	N/A	N/A

requires a Call graph.