

Answer all questions. Time available is 120 min. Maximum mark is 30 points.
You can not use any notes, books or other material during the exam. Please do not communicate with anyone other than the instructor or Teaching Assistant.

Report your answers on the answer sheet provided with the exam.

Question 1. Consider the following program

```
public static int foo(int a, int b) {
    if (a>0 && a>b) {
        int j = a%b;
        while (j>=0) {
            j=j-1;
        }
    }
    return a;
};
```

And consider the following conditions

<p>(a)</p> $Condition1 : \begin{cases} a > 0 \\ a > b \\ j = a \% b \\ j \neq 0 \\ j' = j - 1 \\ j' \neq 0 \\ j'' = j' - 1 \\ j'' = 0 \end{cases}$ $Condition2 : \{ a \leq 0$	<p>(b)</p> $Condition1 : \begin{cases} a > 0 \\ a > b \\ j = a \% b \\ j \neq 0 \\ j' = j - 1 \\ j' \neq 0 \\ j'' = j' - 1 \\ j'' = 0 \end{cases}$ $Condition2 : \{ a \leq 0$ $Condition3 : \begin{cases} a > 0 \\ a \leq b \end{cases}$	<p>(c)</p> $Condition1 : \begin{cases} a > 0 \\ j = a \% b \\ j \neq 0 \\ j' = j - 1 \\ j' \neq 0 \\ j'' = j' - 1 \\ j'' = 0 \end{cases}$ $Condition2 : \begin{cases} a > 0 \\ j = a \% b \\ j \neq 0 \\ j' = j - 1 \\ j' = 0 \end{cases}$
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$\text{Condition1} : \begin{cases} a > 0 \\ j = a \% b \\ j = 0 \end{cases}$ $\text{Condition2} : \begin{cases} a \leq 0 \end{cases}$ <p>(d)</p>	<p>(e)</p> $\text{Condition1} : \begin{cases} a > 0 \\ j = a \% b \\ j = 0 \end{cases}$	<p>(f) none of the previous conditions</p>
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Which of conditions must be satisfied by a set of test cases to ensure instruction/statement coverage?

- (a) The conditions from point (a) and (b)
- (b) The conditions from point (a)
- (c) The conditions from point (b)
- (d) The conditions from point (c) and (d)
- (e) The conditions from point (e)
- (f) The conditions from point (f)

Question 2. Consider the specification from question 1. Which conditions must be satisfied by a set of test cases to ensure branch coverage?

- (a) The conditions from point (a) and (b)
- (b) The conditions from point (b)
- (c) The conditions from point (c)
- (d) The conditions from point (d)
- (e) The conditions from point (e) and (f)
- (f) The conditions from point (f)

Question 3. Consider the program from question 1. Which conditions must be satisfied by a set of test cases to ensure condition coverage?

- (a) The conditions from point (a)
- (b) The conditions from point (b)
- (c) The conditions from point (c)
- (d) The conditions from point (d)
- (e) The conditions from point (e)
- (f) The conditions from point (f)

Question 4. Consider the program from question 1. Which conditions must be satisfied by a set of test cases to ensure path coverage?

- (a) The conditions from point (a)
- (b) The conditions from point (b)
- (c) The conditions from point (c)
- (d) The conditions from point (d)
- (e) The conditions from point (e)
- (f) None of the above

Question 5. Which of the following test cases guarantee instruction/statement coverage?

- (a) Test 1: $\langle a=3, b=1 \rangle$, Test 2: $\langle a=-2, b=1 \rangle$
- (b) Test 1: $\langle a=3, b=1 \rangle$
- (c) Test 1: $\langle a=3, b=1 \rangle$, Test 2: $\langle a=2, b=1 \rangle$
- (d) Test 1: $\langle a=4, b=2 \rangle$, Test 2: $\langle a=-2, b=1 \rangle$
- (e) Test 1: $\langle a=4, b=2 \rangle$
- (f) None of the previous conditions

Question 6. Which of the following test cases guarantee branch coverage?

- (a) Test 1: $\langle a=3, b=1 \rangle$, Test 2: $\langle a=-2, b=1 \rangle$
- (b) Test 1: $\langle a=3, b=1 \rangle$
- (c) Test 1: $\langle a=3, b=1 \rangle$, Test 2: $\langle a=2, b=1 \rangle$
- (d) Test 1: $\langle a=4, b=2 \rangle$, Test 2: $\langle a=-2, b=1 \rangle$
- (e) Test 1: $\langle a=4, b=2 \rangle$
- (f) None of the previous conditions

Question 7. Which of the following test cases guarantee condition coverage?

- (a) Test 1: $\langle a=3, b=1 \rangle$, Test 2: $\langle a=-2, b=1 \rangle$
- (b) Test 1: $\langle a=3, b=1 \rangle$, Test 2: $\langle a=-2, b=1 \rangle$, Test 2: $\langle a=1, b=2 \rangle$
- (c) Test 1: $\langle a=3, b=1 \rangle$, Test 2: $\langle a=2, b=1 \rangle$
- (d) Test 1: $\langle a=4, b=2 \rangle$, Test 2: $\langle a=-2, b=1 \rangle$
- (e) Test 1: $\langle a=4, b=2 \rangle$
- (f) None of the previous conditions

Question 8. Which of the following test cases guarantee path coverage?

- (a) Test 1: $\langle a=3, b=1 \rangle$, Test 2: $\langle a=-2, b=1 \rangle$
- (b) Test 1: $\langle a=3, b=1 \rangle$
- (c) Test 1: $\langle a=3, b=1 \rangle$, Test 2: $\langle a=2, b=1 \rangle$
- (d) Test 1: $\langle a=4, b=2 \rangle$, Test 2: $\langle a=-2, b=1 \rangle$
- (e) Test 1: $\langle a=4, b=2 \rangle$
- (f) None of the previous conditions

Question 9. Consider the following specification for the method “*set_v*”

int set_v(int a, int b)

		Returned Value
$a \leq 45$		16
$a > 45$	$b < 75$	17
	$b = 75$	13
	$b > 75$	45

The implementation of the method *set_v* is

```
int set_v(int a, int b) {
    if (a <= 42)
```

```

        v= 16;
    else
        if (b < 70)
            v = 17;
        else
            if (b == 75)
                v = 12;
            else
                v = 45;
            return v;
    }

```

Consider the following table reporting a set of test cases (one for each row)

#	a	b
1	20	17
2	45	17
3	60	72
4	60	75
5	60	90

Which of the following statement is true:

- (a) The developer used white box techniques for test case definition.
- (b) The developer used black box techniques for test case definition.
- (c) The developer used both black box and white box techniques for test case definition.
- (d) The developer used neither black box nor white box techniques for test case definition.
- (e) The test cases are not valid
- (f) The values specified for a and b by the test cases are not valid

Question 10. Consider the example from Question 9. What of the following statements does not hold

- (a) for the test case a=20 and b=17 the expected value is 16
- (b) for the test case a=45 and b=80 the expected value is 45
- (c) for the test case a=20 and b=80 the expected value is 16
- (d) for the test case a=20 and b=17 the expected value is 16
- (e) for the test case a=43 and b=60 the expected value is 17
- (f) None of the previous statements holds

Question 11. Consider the example from Question 9. What of the following statements does not hold

- (a) for the test case a=20 and b=17 the returned value is 16
- (b) for the test case a=45 and b=80 the returned value is 45
- (c) for the test case a=20 and b=80 the returned value is 16
- (d) for the test case a=20 and b=17 the returned value is 16
- (e) for the test case a=43 and b=60 the returned value is 16

- (f) None of the previous statements holds

Question 12. Consider the example from Question 9. What of the following test cases shows a failure

- (a) the test case a=20 and b=17
- (b) the test case a=45 and b=80
- (c) the test case a=20 and b=80
- (d) the test case a=20 and b=17
- (e) the test case a=43 and b=60
- (f) None of the previous tests

Question 13. Which of the following statements is NOT correct:

- (a) The testing activity succeeds when failures are detected
- (b) The testing may be not binary
- (c) White box testing enables engineers to analyze the internal elements of the system
- (d) Black box testing does not enable engineers to analyze the internal elements of the system
- (e) Testing should also consider qualities such as the robustness of the software
- (f) All the previous statements are correct

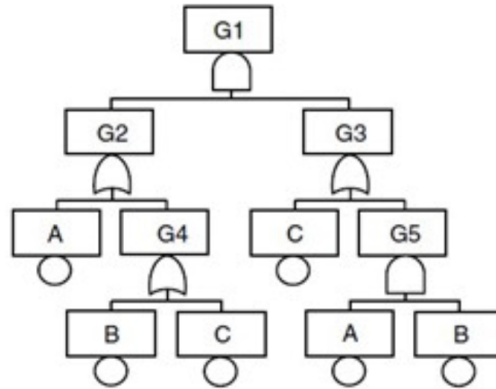
Question 14. Which of the following statements is NOT correct:

- (a) A failure is detected when the system outcome matches the expected output
- (b) An error is the cause of the failure
- (c) A set of test cases should be able to identify system failures (if present)
- (d) One testing technique relies on random generation of inputs
- (e) To generate test inputs engineers often try to partition the input domain into different areas
- (f) All the previous statements are correct

Question 15. Which of the following statements is correct:

- (a) It is always possible to cover 100% of the code instructions
- (b) If a set of test cases ensures instruction coverage it also ensure branch coverage
- (c) It is always possible to ensure path coverage
- (d) If a set of test cases ensures branch coverage it also ensure path coverage
- (e) Instruction coverage requires to cover all the instructions of a program
- (f) All the previous statements are NOT correct

Question 16. Consider the following Fault Tree:



The MOCUS algorithm returns the following cut sets (each cut set is indicated with the keyword CT):

- (a) CT1=[A,C], CT2=[A,B],CT3=[B,C],CT4=[A,B],CT5=[C],CT6=[A,B,C]
- (b) CT1=[A,C], CT3=[B,C],CT4=[A,B],CT5=[C],CT6=[A,B,C,D]
- (c) CT1=[A,C], CT3=[B,C],CT4=[A,B],CT5=[C],CT6=[A,B,C], CT7=[A]
- (d) CT1=[A,C], CT3=[B,C],CT4=[A,B],CT5=[C]
- (e) CT1=[A,C], CT3=[B,C],CT4=[A,B],CT5=[C],CT6=[A,B,C],CT7=[B]
- (f) All the previous cut sets are NOT correct

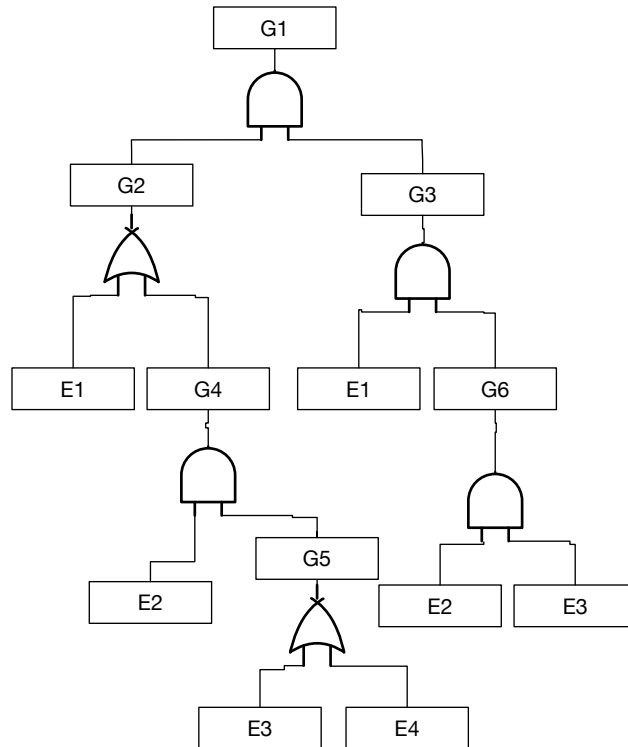
Question 17. Consider the Fault Tree from question 16. The minimal cut sets are

- (a) CT1=[C], CT2=[A,B]
- (b) CT1=[C], CT2=[A]
- (c) CT1=[C], CT2=[A,B], CT3=[A,C]
- (d) CT1=[C], CT2=[A,C]
- (e) CT1=[C], CT2=[A,B], CT4=[A,B,C]
- (f) CT1=[B], CT2=[A,B]

Question 18. Which of the following statements is NOT correct

- (a) Fault Tree Analysis (FTA) is a top-down method
- (b) Failure Modes & Effects Analysis (FMEA) is a bottom-up method
- (c) Systems Theoretic Process Analysis (STPA) treats accidents as a control problem
- (d) FTA does not enable to “OR” decompose hazards
- (e) FTA enables to “AND” decompose hazards
- (f) FTA relies on a tree-like structure

Question 19. Consider the following Fault Tree



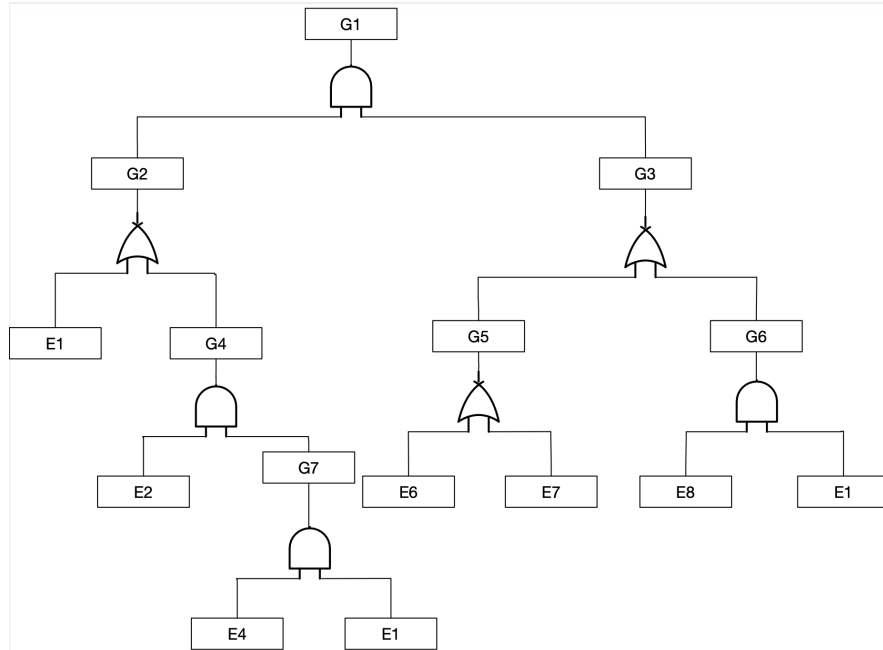
The MOCUS algorithm returns the following cut sets (each cut set is indicated with the keyword CT):

- (a) CT1=[E1,E2,E3], CT2=[E1,E2,E3],CT3=[E1,E2,E3,E4]
- (b) CT1=[E1,E2,E3], CT2=[E1,E2],CT3=[E1,E2,E3,E4]
- (c) CT1=[E1,E3], CT2=[E1,E2,E3],CT3=[E1,E2,E3,E4]
- (d) CT1=[E1,E2,E3], CT2=[E1,E2,E3],CT3=[E1,E3,E4]
- (e) CT1=[E1,E2,E3], CT2=[E1],CT3=[E1,E2,E3,E4]
- (f) All the previous cut sets are NOT correct

Question 20. Consider the Fault Tree from question 19. The minimal cut sets are

- (a) CT1=[E1,E2,E3]
- (b) CT1=[E1,E2,E3], CT3=[E1,E2,E3,E4]
- (c) CT1=[E1,E3]
- (d) CT1=[E1,E2,E3], CT2=[E1],CT3=[E1,E2,E3,E4]
- (e) CT1=[E1,E3], CT2=[E1,E2,E3],CT3=[E1,E2,E3,E4]
- (f) None of the above

Question 21. Consider the following Fault Tree



The MOCUS algorithm returns the following cut sets (each cut set is indicated with the keyword CT):

- (a) CT1=[E1,E6], CT2=[E1,E7],CT3=[E1,E8],CT4=[E1,E2,E4,E6] ,CT5=[E1,E2,E4,E7] , CT6=[E1,E2,E4,E6]
- (b) CT1=[E1,E7],CT2=[E1,E8],CT3=[E1,E2,E4,E6] ,CT4=[E1,E2,E4,E7] , CT5=[E1,E2,E4,E6]
- (c) CT1=[E1,E6],CT2=[E1,E8],CT3=[E1,E2,E4,E6] ,CT4=[E1,E2,E4,E7] , CT5=[E1,E2,E4,E6]
- (d) CT1=[E1,E6], CT2=[E1,E2],CT3=[E1,E8],CT4=[E1,E2,E4,E6] ,CT5=[E1,E2,E4,E7] , CT6=[E1,E2,E4,E6]
- (e) CT1=[E2,E6], CT2=[E1,E7],CT3=[E1,E8],CT4=[E1,E2,E4,E6] ,CT5=[E1,E2,E4,E7] , CT6=[E1,E2,E4,E6]
- (f) All the previous cut sets are NOT correct

Question 22. Consider the Fault Tree from question 21. The minimal cut sets are

- (a) CT1=[E1,E6], CT2=[E1,E7],CT3=[E1,E8]
- (b) CT1=[E1,E6], CT2=[E1,E7]
- (c) CT1=[E1,E7],CT2=[E1,E8]
- (d) CT1=[E1,E6], CT2=[E1,E2]
- (e) CT1=[E1,E7],CT2=[E1,E8]
- (f) None of the above

Question 23. Consider the following program

```

if (x==0 && y==0 && z==0) {
    << Statements >>
}
else {
    << Statements >>
}

```


Which of the following test cases ensure instruction coverage?

- (a) T1=[x=1,y=1,z=1], T1=[x=2,y=2,z=2]
- (b) T1=[x=0,y=0,z=0], T1=[x=2,y=2,z=2]
- (c) T1=[x=0,y=1,z=0], T1=[x=0,y=0,z=1]
- (d) T1=[x=0,y=0,z=0]
- (e) T1=[x=3,y=3,z=3]
- (f) None of the above

Question 24. Consider the program from question 23. Which of the following test cases ensure branch coverage?

- (a) T1=[x=1,y=1,z=1], T1=[x=2,y=2,z=2]
- (b) T1=[x=0,y=0,z=0], T1=[x=2,y=2,z=2]
- (c) T1=[x=0,y=1,z=0], T1=[x=0,y=0,z=1]
- (d) T1=[x=0,y=0,z=0]
- (e) T1=[x=3,y=3,z=3]
- (f) None of the above

Question 25. Consider the program from question 23. Which of the following test cases ensure condition coverage?

- (a) T1=[x=1,y=1,z=1], T1=[x=2,y=2,z=2]
- (b) T1=[x=0,y=0,z=0], T1=[x=2,y=2,z=2]
- (c) T1=[x=0,y=1,z=0], T1=[x=0,y=0,z=1]
- (d) T1=[x=0,y=0,z=0], T2=[x=1,y=0,z=1], T3=[x=0,y=1,z=1], T4=[x=0,y=0,z=1]
- (e) T1=[x=3,y=3,z=3]
- (f) None of the above

Question 26. Consider the program from question 23. Which of the following test cases ensure path coverage?

- (a) T1=[x=1,y=1,z=1], T1=[x=2,y=2,z=2]
- (b) T1=[x=0,y=0,z=0], T1=[x=2,y=2,z=2]
- (c) T1=[x=0,y=1,z=0], T1=[x=0,y=0,z=1]
- (d) T1=[x=0,y=0,z=0], T2=[x=1,y=0,z=1], T3=[x=0,y=1,z=1], T4=[x=0,y=0,z=1]
- (e) T1=[x=3,y=3,z=3]
- (f) None of the above

Question 27. Consider the following program

```
if (x==0 && (y==0 && z==0)) {  
    << Statements >>  
}  
else {  
    << Statements >>  
}
```

Which of the following test cases ensure instruction coverage?

- (a) T1=[x=1,y=1,z=1], T1=[x=2,y=2,z=2]

- (b) $T1=[x=0,y=0,z=0]$, $T1=[x=2,y=2,z=2]$
- (c) $T1=[x=0,y=1,z=0]$, $T1=[x=0,y=0,z=1]$
- (d) $T1=[x=0,y=0,z=0]$
- (e) $T1=[x=3,y=3,z=3]$
- (f) None of the above

Question 28. Consider the program from question 27. Which of the following test cases ensure branch coverage?

- (a) $T1=[x=1,y=1,z=1]$, $T1=[x=2,y=2,z=2]$
- (b) $T1=[x=0,y=0,z=0]$, $T1=[x=2,y=2,z=2]$
- (c) $T1=[x=0,y=1,z=0]$, $T1=[x=0,y=0,z=1]$
- (d) $T1=[x=0,y=0,z=0]$
- (e) $T1=[x=3,y=3,z=3]$
- (f) None of the above

Question 29. Consider the program from question 27. Which of the following test cases ensure condition coverage?

- (a) $T1=[x=1,y=1,z=1]$, $T1=[x=2,y=2,z=2]$
- (b) $T1=[x=0,y=0,z=0]$, $T1=[x=2,y=2,z=2]$
- (c) $T1=[x=0,y=1,z=0]$, $T1=[x=0,y=0,z=1]$
- (d) $T1=[x=0,y=0,z=0]$, $T2=[x=1,y=0,z=1]$, $T3=[x=0,y=1,z=1]$, $T4=[x=0,y=0,z=1]$
- (e) $T1=[x=3,y=3,z=3]$
- (f) None of the above

Question 30. Consider the program from question 27. Which of the following test cases ensure path coverage?

- (a) $T1=[x=1,y=1,z=1]$, $T1=[x=2,y=2,z=2]$
- (b) $T1=[x=0,y=0,z=0]$, $T1=[x=2,y=2,z=2]$
- (c) $T1=[x=0,y=1,z=0]$, $T1=[x=0,y=0,z=1]$
- (d) $T1=[x=0,y=0,z=0]$, $T2=[x=1,y=0,z=1]$, $T3=[x=0,y=1,z=1]$, $T4=[x=0,y=0,z=1]$
- (e) $T1=[x=3,y=3,z=3]$
- (f) None of the above