Q1.2- white box test design for 100% branch coverage

Test Case Design for 100% Branch Coverage

1. `percentage_grade` Method

Test Case Number	Test Data	Expected Results	Conditions Covered	Branches Covered
1	%{homework: [], labs: [0.8, 0.7], midterm: 0.6, final: 0.7}	48	Empty homework, non-empty labs	homework count == 0 (true), labs count == 0 (false)
2	%{homework: [0.7, 0.8], labs: [], midterm: 0.6, final: 0.7}	55.5	Non-empty homework, empty labs	homework count == 0 (false), labs count == 0 (true)
3	%{homework: [0.7, 0.8], labs: [0.8, 0.7], midterm: 0.6, final: 0.7}	70,5	Non-empty homework and labs	homework count == 0 (false), labs count == 0 (false)
4	%{homework: [], labs: [], midterm: 0.6, final: 0.7}	33	Empty homework and labs	homework count == 0 (true), labs count == 0 (true)

2. `letter_grade` Method

Test Case Number	Test Data	Expected Results	Conditions Covered	Branches Covered
1	%{homework: [], labs: [], midterm: 0.3, final: 0.3}	"EIN"	Homework and labs lists are empty avg_homework < 0.4, avg homework <0.4	All branches for empty homework and labs lists, avg_homework < 0.4, avg_exams < 0.4
2	%{homework: [0.7, 0.8], labs: [], midterm: 0.3, final: 0.4}	"EIN"	Homework is not empty,Empty labs, avg_exams < 0.4	labs count == 0 (true), avg_exams < 0.4 (true)
3	%{homework: [0.7, 0.8], labs: [0.9, 0.8, 0.85], midterm: 0.8, final: 0.9}	"A+"	homework and labs lists are not empty, avg_homework >= 0.4, avg_exams >= 0.4, num_labs >= 3	avg_homework >= 0.4, avg_exams >= 0.4, num_labs >= 3, mark calculation and grade determination for A+
4	%{homework: [0.9, 0.9], labs: [0.9, 0.9, 0.9], midterm: 0.9, final: 0.9}	"A"	homework, labs, midterm, final	Grade determination for A
5	%{homework: [0.6, 0.7], labs: [0.7, 0.6, 0.65], midterm: 0.7, final: 0.75}	"A-"	homework, labs, midterm, final	Grade determination for A-
6	%{homework: [0.6, 0.6], labs: [0.7, 0.6, 0.65], midterm: 0.65, final: 0.7}	"B+"	homework, labs, midterm, final	Grade determination for B+

Test Case Number	Test Data	Expected Results	Conditions Covered	Branches Covered
7	%{homework: [0.5, 0.6], labs: [0.6, 0.5, 0.55], midterm: 0.6, final: 0.65}	"B"	homework, labs, midterm, final	Grade determination for B
8	%{homework: [0.5, 0.5], labs: [0.5, 0.5, 0.5], midterm: 0.55, final: 0.6}	"C+"	homework, labs, midterm, final	Grade determination for C+
9	%{homework: [0.4, 0.5], labs: [0.5, 0.4, 0.45], midterm: 0.5, final: 0.55}	"C"	homework, labs, midterm, final	Grade determination for C
10	%{homework: [0.4, 0.4], labs: [0.4, 0.3, 0.35], midterm: 0.45, final: 0.5}	"D+"	homework, labs, midterm, final	Grade determination for D+
11	%{homework: [0.4, 0.4], labs: [0.4, 0.4, 0.4], midterm: 0.4, final: 0.45}	"D"	homework, labs, midterm, final	Grade determination for D
12	%{homework: [0.3, 0.3], labs: [0.3, 0.3, 0.3], midterm: 0.3, final: 0.35}	"E"	homework, labs, midterm, final	Grade determination for E

Test Case Number	Test Data	Expected Results	Conditions Covered	Branches Covered
13	%{homework: [0.2, 0.2], labs: [0.2, 0.2, 0.2], midterm: 0.2, final: 0.25}	"F"	homework, labs, midterm, final	Grade determination for F

3. `numeric_grade` Method

Test Case Number	Test Data	Expected Results	Conditions Covered	Branches Covered
1	%{homework: [], labs: [0.8, 0.7], midterm: 0.6, final: 0.7}	0	Empty homework, avg_homework < 0.4	homework count == 0 (true), avg_homework < 0.4 (true)
2	%{homework: [0.7, 0.8], labs: [], midterm: 0.3, final: 0.4}	0	homework and labs lists are empty, avg_homework < 0.4 avg_exams < 0.4	All branches for empty homework and labs lists, avg_homework < 0.4, avg_exams < 0.4
3	%{homework: [0.7, 0.8], labs: [0.1, 0.2], midterm: 0.6, final: 0.7}	0	num_labs < 3	num_labs < 3 (true)
4	%{homework: [0.9, 0.9], labs: [0.9, 0.9, 0.9], midterm: 0.9, final: 0.9}	10	homework and labs lists are not empty, avg_homework >= 0.4, avg_exams >= 0.4, num_labs >= 3	avg_homework >= 0.4

Test Case Number	Test Data	Expected Results	Conditions Covered	Branches Covered
5	%{homework: [0.85, 0.85], labs: [0.85, 0.85, 0.85], midterm: 0.85, final: 0.85}	9	homework and labs lists are not empty, avg_homework >= 0.4, avg_exams >= 0.4, num_labs >= 3	mark > 0.845 (true)
6	%{homework: [0.4, 0.4], labs: [0.4, 0.4, 0.4], midterm: 0.4, final: 0.4}	1	Low passing marks	mark > 0.395 (true)

Q1.3

The degree of statement coverage obtained is 47.83% for the Grades. Calculator module.

Achieving 100% coverage might be hindered by missing test cases, complex logic, or untested error handling paths.

Addressing the limitations of statement-level coverage involves ensuring branch, path, and function coverage, using mutation testing, and leveraging advanced tools.

Q2.4

Additional Refactoring 1: Extract grade_to_letter/1 Helper Method

We can extract a helper method grade_to_letter to handle the conversion of a numerical grade to a letter grade. This will further clean up the letter_grade/1 and numeric_grade/1 functions.

Additional Refactoring 2: Extract grade_to_numeric/1 Helper Method

Similarly, we can extract a helper method grade_to_numeric to handle the conversion of a numerical grade to a numeric grade.