Question 1: The Number Sign Checker ➕➖

Concept: Basic Nested If-Else

Write a program that takes an integer and provides detailed analysis:

- First check if the number is zero
- If not zero, check if positive or negative
- For positive numbers, check if even or odd
- For negative numbers, check if divisible by 3

Sample Input/Output:

Enter a number: 15
Number is: Positive
Property: Odd number

Special: Not a perfect square

Question 2: The Grade Calculator with Bonus 📊

Concept: Nested If-Else with Multiple Conditions

Calculate final grade with attendance bonus. Input marks (0-100) and attendance percentage:

- If marks >= 50: Check attendance for bonus
  - Attendance >= 90%: Add 5 marks
  - Attendance >= 75%: Add 3 marks
- If marks < 50: Check if attendance can help pass
  - Attendance >= 95%: Add 7 marks (mercy bonus)

Sample Input/Output:

Enter marks: 48
Enter attendance %: 96
Original marks: 48
Attendance bonus: 7 marks (mercy bonus applied!)
Final marks: 55

Status: PASS

Question 3: The Simple Calculator Menu 🧮

Concept: Nested Switch-Case

Create a calculator with main menu (1=Basic, 2=Advanced) and submenus:

- Basic: Addition(1), Subtraction(2), Multiplication(3), Division(4)
- Advanced: Power(1), Modulus(2), Absolute Difference(3)

Sample Input/Output:

Main Menu: 1-Basic, 2-Advanced
Enter choice: 2
Advanced Operations: 1-Power, 2-Modulus, 3-Absolute Difference
Enter choice: 1
Enter two numbers: 2 3

Result: 2 ^ 3 = 8

Question 4: The Leap Year Checker 📅

Concept: Complex Nested Conditions with Logical Operators

Check if a year is a leap year using nested conditions:

- If divisible by 4: Check further conditions
    - If divisible by 100: Must also be divisible by 400
    - Otherwise: It's a leap year
- Also calculate days in February for that year

Sample Input/Output:

Enter year: 2024
2024 is divisible by 4
2024 is not divisible by 100
Result: LEAP YEAR!

February has 29 days in 2024

Question 5: The Discount Calculator 💰

Concept: Ternary Operators (Simple and Nested)

Calculate discount using ternary operators:

- Base discount = (amount > 1000) ? 10 : 5
- Age discount = (age >= 60) ? ((amount > 500) ? 15 : 10) : 0
- Final discount is sum of both

Sample Input/Output:

Enter amount: 1200
Enter age: 65
Base discount: 10%
Senior citizen discount: 15%
Total discount: 25%
Amount after discount: 900.00

You saved: 300.00

Question 6: The Triangle Type Identifier 📐

Concept: Nested Decisions with Math Functions

Input three sides of a triangle. Check validity and classify:

1. First check if valid (sum of any two > third)
2. If valid, check type using nested conditions
3. Calculate perimeter and area using sqrt() from math.h
4. Check if it's a right triangle using Pythagorean theorem

Sample Input/Output:

Enter three sides: 3 4 5
Valid triangle!
Type: Scalene triangle
Perimeter: 12.00
Area: 6.00

Special: This is a RIGHT TRIANGLE!

Question 7: The Time Converter ⏰

Concept: Arithmetic and Modulus with Nested Conditions

Convert seconds to hours, minutes, and seconds format:

- Input total seconds
- If >= 3600: Calculate hours, then check remaining for minutes
- If < 3600 but >= 60: Calculate only minutes and seconds
- If < 60: Display only seconds

Sample Input/Output:

Enter total seconds: 3665
Time breakdown:
1 hour(s)
1 minute(s)
5 second(s)

Formatted: 01:01:05

Question 8: The Number Properties Analyzer 🔢

Concept: Multiple Nested Conditions with Different Operators

Analyze a number for multiple properties using nested structures:

1. Check if Prime (using nested loop simulation with modulus)
2. Check if Perfect Square (using sqrt from math.h)
3. Check if Power of 2 (using bitwise operations)
4. Check digit count (using repeated division)

Sample Input/Output:

Enter a positive number: 16
Digit count: 2
Perfect square: Yes (4 × 4)
Power of 2: Yes (2^4)
Prime: No

Binary value: 10000

Question 9: The Quadratic Solver 📈

Concept: Math Functions with Complex Nested Logic

Solve ax² + bx + c = 0:

1. Check if a = 0 (linear equation)
2. Calculate discriminant
3. Based on discriminant, find roots:
   - If > 0: Two real roots (use sqrt)
   - If = 0: One real root
   - If < 0: Complex roots (calculate real and imaginary parts)

Sample Input/Output:

Enter coefficients a, b, c: 1 -3 2
Equation: 1x² - 3x + 2 = 0
Discriminant: 1.00
Nature: Two distinct real roots
Root 1: 2.00

Root 2: 1.00

Question 10: The Banking System 🏦

Concept: Comprehensive - All Concepts Combined

Create a banking system with PIN validation and transactions:

1. PIN verification (3 attempts using decrement operator)
2. Main menu using switch
3. Withdrawal: Check balance, daily limit, use ternary for fee
4. Deposit: Validate amount using nested conditions
5. Interest calculator using pow() from math.h
6. Use bitwise operators for fast calculations (multiply by 2: <<1)
7. Check transaction count using modulus

Sample Input/Output:

Enter 4-digit PIN: 1234
Welcome! Balance: 5000.00

=== MENU ===
1. Withdraw
2. Deposit
3. Calculate Interest
4. Quick Double Check
5. Exit

Choice: 3
Enter years: 2
Interest rate: 5.5%
Simple Interest: 550.00
Compound Interest (using pow): 563.78

Future value: 5563.78

Bonus Challenge: The Dice Game Simulator 🎲

Concept: Advanced Nested Logic with Probability

Simulate a dice game without arrays:

1. Generate dice value using mathematical formula: (user_input % 6) + 1
2. Nested conditions for game rules:
    ○ If roll = 6: Roll again (bonus roll)
    ○ If two 6s in a row: Jackpot
    ○ If roll = 1: Lose turn
3. Calculate points using nested ternary operators
4. Use bitwise operations for score multipliers

Sample Input/Output:

Enter a number for dice roll: 47
Dice shows: 6
Great! You get a bonus roll!
Enter another number: 23
Dice shows: 6
JACKPOT! Double 6s!
Points earned: 100
Multiplier active: 2x (using bitwise shift)

Final score: 200