**Test Case 1: Basic Feasibility Test**

**2**

**100**

**100**

**4**

**10 10 30 1**

**20 20 40 2**

**30 30 50 3**

**40 40 60 4**

* **Objective**: Ensure that the system can assign packages to vehicles without exceeding their capacities.
* **Input**:
  + **Vehicles**: 2 vehicles, each with a capacity of 100 kg.
  + **Packages**: 4 packages with the following weights: 30 kg, 40 kg, 50 kg, and 60 kg.
* **Expected Outcome**:
  + Packages are distributed among vehicles such that no vehicle carries more than 100 kg.
  + All packages are assigned to vehicles.
* **Validation Criteria**:
  + Total weight per vehicle ≤ 100 kg.
  + No unassigned packages remain.

**Test Case 2: Priority Handling Test**

**1**

**100**

**3**

**10 10 50 1**

**20 20 50 2**

**30 30 50 3**

* **Objective**: Verify that higher-priority packages are delivered before lower-priority ones when possible.
* **Input**:
  + **Vehicles**: 1 vehicle with a capacity of 100 kg.
  + **Packages**:
    - Package A: 50 kg, Priority 1
    - Package B: 50 kg, Priority 2
    - Package C: 50 kg, Priority 3
* **Expected Outcome**:
  + Packages A and B are selected for delivery due to higher priority.
  + Package C is deferred or unassigned due to capacity constraints.
* **Validation Criteria**:
  + Delivered packages have the highest possible priorities within capacity limits.

**Test Case 3:** **Distance Optimization Test**

**2**

**100**

**100**

**6**

**10 10 20 1**

**20 20 30 2**

**80 80 25 3**

**85 85 30 4**

**15 15 10 2**

**90 90 20 5**

* **Objective**: Ensure that the system minimizes the total distance travelled by all vehicles.
* **Input**:
  + **Vehicles**: 2 vehicles, each with a capacity of 100 kg.
  + **Packages**: 6 packages located at varying distances from the depot.
* **Expected Outcome**:
  + Packages are assigned and routed to minimize the combined distance travelled by both vehicles.
* **Validation Criteria**:
  + Total distance travelled is less than or equal to a predefined threshold based on optimal routing calculations.

**Test Case 4:** **Edge Case - Overcapacity Package**

**2**

**100**

**100**

**1**

**50 50 150 2**

* **Objective**: Test the system's behaviour when a package exceeds the capacity of all available vehicles.
* **Input**:
  + **Vehicles**: 2 vehicles, each with a capacity of 100 kg.
  + **Packages**: 1 package weighing 150 kg.
* **Expected Outcome**:
  + The system identifies that the package cannot be delivered due to weight constraints.
  + Appropriate handling or notification is provided.
* **Validation Criteria**:
  + Package is not assigned to any vehicle.
  + System logs or reports the issue clearly.

**Test Case 5:** **Simulated Annealing vs. Genetic Algorithm Comparison**

**3**

**100**

**100**

**100**

**10**

**10 10 20 1**

**20 30 15 2**

**40 10 30 3**

**60 60 25 4**

**15 15 10 2**

**80 90 35 1**

**25 25 15 3**

**50 50 30 2**

**35 45 10 1**

**45 65 20 5**

* **Objective**: Compare the performance of both algorithms in terms of solution quality and computation time.
* **Input**:
  + **Vehicles**: 3 vehicles, each with a capacity of 100 kg.
  + **Packages**: 10 packages with varying weights and priorities.
* **Expected Outcome**:
  + Both algorithms produce valid solutions.
  + Performance metrics (e.g., total distance, computation time) are recorded for comparison.
* **Validation Criteria**:
  + Solutions meet all constraints.
  + Comparative analysis highlights strengths and weaknesses of each algorithm.

**Test Case 6: Scalability Test**

**10**

**100**

**100**

**100**

**100**

**100**

**100**

**100**

**100**

**100**

**100**

**10**

**5 5 15 1**

**10 20 18 2**

**15 25 12 3**

**20 30 14 4**

**25 35 19 5**

**30 40 10 2**

**35 45 13 1**

**40 50 11 3**

**45 55 17 4**

**50 60 16 2**

* **Objective**: Assess the system's performance with a large number of packages and vehicles.
* **Input**:
  + **Vehicles**: 10 vehicles, each with a capacity of 100 kg.
  + **Packages**: 100 packages with random weights and priorities.
* **Expected Outcome**:
  + System processes all packages efficiently.
  + All constraints are satisfied.
* **Validation Criteria**:
  + Reasonable computation time (e.g., under 5 minutes).
  + Valid assignments without capacity violations.

**Test Case 7: User Interface Display Test**

* **Objective**: Verify that the user interface correctly displays the solution.
* **Input**:
  + Use any of the above scenarios.
* **Expected Outcome**:
  + UI presents vehicle routes, package assignments, and relevant metrics clearly.
* **Validation Criteria**:
  + All information is accurate and user-friendly.
  + No display errors or inconsistencies.