

Module 18: Absolute Values - Complete Notes

What You'll Learn

In this module, you'll master **absolute values** — distance from zero, error margins, and tolerance checking.

Concept Explained (Like a YouTube Video)

The Basics

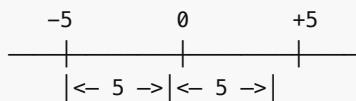
Absolute value is the distance from zero — always positive.

$$\begin{aligned} |5| &= 5 && \text{(5 units from zero)} \\ |-5| &= 5 && \text{(also 5 units from zero)} \\ |0| &= 0 && \text{(zero units from zero)} \end{aligned}$$

Key: $|x|$ removes the sign, keeps magnitude

Visual Understanding

Number line:



Both -5 and $+5$ are distance 5 from zero

Distance Between Values

Distance from A to B = $|A - B|$

Example: Distance between 3 and 7

$$\begin{aligned} |3 - 7| &= |-4| = 4 \\ |7 - 3| &= |4| = 4 \quad \text{(same!)} \end{aligned}$$

Order doesn't matter with absolute value!

Programming Connection

Code Examples

```
# Example 1: Basic Absolute Value

# Built-in abs() function
print(abs(5))      # 5
print(abs(-5))     # 5
print(abs(0))       # 0
print(abs(-3.7))   # 3.7
```

```
# Manual implementation
def absolute(x):
    return x if x >= 0 else -x
```

```
# Example 2: Distance Between Values

def distance(a, b):
    """Distance between two values (always positive)"""
    return abs(a - b)

print(distance(10, 3))    # 7
print(distance(3, 10))    # 7 (order doesn't matter)
print(distance(-5, 5))   # 10
```

```
# Example 3: Tolerance Checking (THE BIG ONE)

def within_tolerance(actual, expected, tolerance):
    """Check if actual is within tolerance of expected"""
    return abs(actual - expected) <= tolerance

# Is 98 within ±5 of 100?
print(within_tolerance(98, 100, 5))    # True (diff = 2)
print(within_tolerance(94, 100, 5))     # False (diff = 6)

# Floating point comparison
def almost_equal(a, b, epsilon=1e-9):
    return abs(a - b) < epsilon

print(almost_equal(0.1 + 0.2, 0.3))    # True!
```

```
# Example 4: Error Margin Calculation

def calculate_error(measured, actual):
    """Calculate absolute and percentage error"""
    abs_error = abs(measured - actual)
    pct_error = (abs_error / abs(actual)) * 100 if actual != 0 else 0

    return {
        "measured": measured,
        "actual": actual,
        "absolute_error": abs_error,
        "percentage_error": round(pct_error, 2)
    }

result = calculate_error(98, 100)
print(result)  # {'absolute_error': 2, 'percentage_error': 2.0}
```

```
# Example 5: Find Closest Value

def find_closest(target, values):
    """Find value closest to target"""
    return min(values, key=lambda v: abs(v - target))

values = [10, 25, 47, 82, 95]
print(find_closest(50, values)) # 47 (closest to 50)
print(find_closest(80, values)) # 82 (closest to 80)
```

SDET/Testing Application

```
# SDET Scenario: Validate With Tolerance

def validate_value(actual, expected, tolerance_pct):
    """Validate value within percentage tolerance"""
    tolerance = expected * tolerance_pct / 100
    diff = abs(actual - expected)

    return {
        "actual": actual,
        "expected": expected,
        "difference": diff,
        "tolerance": tolerance,
        "passed": diff <= tolerance,
        "status": "✅ PASS" if diff <= tolerance else "❌ FAIL"
    }

# Response time within 10% of baseline
result = validate_value(108, 100, 10)
print(f"Status: {result['status']}") # ✅ PASS (diff=8, tolerance=10)
```

```
# SDET Scenario: Performance Deviation Check
```

```
def check_deviation(baseline_times, current_time, max_deviation_pct):
    """Check if current time deviates too much from baseline avg"""
    baseline_avg = sum(baseline_times) / len(baseline_times)
    deviation = abs(current_time - baseline_avg)
    max_allowed = baseline_avg * max_deviation_pct / 100

    return {
        "baseline_avg": round(baseline_avg, 2),
        "current": current_time,
        "deviation": round(deviation, 2),
        "max_allowed": round(max_allowed, 2),
        "within_bounds": deviation <= max_allowed
    }
```

```
baseline = [100, 105, 98, 102, 95]
result = check_deviation(baseline, 115, 10)
print(result)
```

🎓 Practice Problems

Problem 1: Easy 🟢

Challenge: What is $| -7 - 3 |$?

Problem 2: Medium 🟡

Scenario: Expected response time is 200ms. Acceptable tolerance is $\pm 15\%$.

Challenge: What's the valid range? Is 225ms acceptable?

Problem 3: Application 🟥

Scenario: You have sensor readings: [98.5, 101.2, 99.8, 100.5]. Target is 100.

Challenge: Find which reading is closest to target and which is furthest.

⚠ Common Mistakes

✗ **Mistake 1:** Thinking $|a - b| \neq |b - a|$

✓ **Fix:** They're always equal! Distance is symmetric.

✗ **Mistake 2:** Using signed difference for error

✓ **Fix:** Always use `abs()` for magnitude of error

🔑 Key Takeaways

✓ **Absolute = Distance from zero** — Always non-negative

✓ **$|a - b| =$ Distance between a and b**

✓ **Tolerance check:** `abs(actual - expected) <= tolerance`

✓ **Order doesn't matter:** `abs(a - b) == abs(b - a)`

💾 Save as: `Module_18_Absolute_Values.md`

Phase 3 Complete! 🚀