Hypothesis Testing Assignment Solutions.

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Question 1

Null Hypothesis (H_o):
It is a statement that assumes no effect, no difference, or no relationship exists in the population.
Importance:

- Provides a baseline for testing.
- Helps avoid bias by requiring evidence before rejecting it.
- Ensures statistical conclusions are based on data, not assumptions.

Question 2

Significance Level (α):
It represents the probability of rejecting the null hypothesis when it is actually true.

- Common values: 0.05, 0.01.
- Example: α = 0.05 means a 5% risk of making a Type I error.

Question 3

Type I Error (α): Rejecting H_o when it is true (false positive).
Type II Error (β): Failing to reject H_o when it is false (false negative).

Question 4

- One-tailed test: Tests for effect in one direction.

Example: Testing if average salary > ₹50,000.

- Two-tailed test: Tests for effect in both directions.

Example: Testing if average salary ≠ ₹50,000.

Question 5

Claim: μ = 10 minutes.
Sample: n = 9, $\bar{x}$ = 12, s = 3, α = 0.05.
Test statistic (t):

$$t = \frac{\bar{x} - \mu}{s/\sqrt{n}} = \frac{12 - 10}{3/\sqrt{9}} = \frac{2}{1} = 2$$

Degrees of freedom = 8.
Critical t (two-tailed, α = 0.05) ≈ 2.306.
Since 2 < 2.306 → **Fail to reject H_o.**
No significant evidence that average time differs from 10 minutes.

Question 6

Use Z-test when:

- Population standard deviation (σ) is known.
- Sample size is large (n ≥ 30).

Use t-test when:

- σ is unknown.
- Sample size is small (n < 30).

Question 7

Paired t-test (Before vs After):
Differences: (5, 5, 1, 3, 1, 3).
Mean difference = 3.
SD of differences ≈ 1.63.
Test statistic:

$$t = \frac{\bar{d}}{s_d/\sqrt{n}} = \frac{3}{1.63/\sqrt{6}} \approx 4.52$$

df = 5, critical t ≈ 2.571.
Since 4.52 > 2.571 → **Reject H_o.**
Training significantly improved productivity.

Question 8

Chi-square test of independence:
Expected frequencies:

- Male-A: (50×40)/100 = 20.
- Male-B: (50×60)/100 = 30.
- Female-A: 20.
- Female-B: 30.

$$\chi^2 = \sum \frac{(O-E)^2}{E} = \frac{(30-20)^2}{20} + \frac{(20-30)^2}{30} + \frac{(10-20)^2}{20} + \frac{(40-30)^2}{30}$$

= 5 + 3.33 + 5 + 3.33 = 16.66.
df = (2-1)(2-1) = 1.
Critical χ^2 (α=0.05, df=1) = 3.84.
Since 16.66 > 3.84 → **Reject H_o.**
Product preference is **not independent** of gender.