Hypothesis Testing Cheat Sheet

📘 1. Hypothesis Definitions

- **Null Hypothesis** (H_0): Assumes no effect or no difference
- **Alternative Hypothesis** (H_1 **or** H_a): Assumes an effect or difference exists

Examples:

- $H_0 : \mu = \mu_0$ vs. $H_1 : \mu \neq \mu_0$ (two-tailed)
- $H_1 : \mu > \mu_0$ or $H_1 : \mu < \mu_0$ (one-tailed)

📕 2. Steps in Hypothesis Testing

1. **State the hypotheses** (H_0, H_1)
2. **Choose significance level** (α, commonly 0.05 or 0.01)
3. **Select the test statistic** (e.g., z, t, chi-square)
4. **Compute the test statistic value**
5. **Determine critical value(s) or p-value**
6. **Make a decision**:
    - If $\text{p-value} < \alpha$: Reject H_0
    - If $\text{p-value} \geq \alpha$: Do not reject H_0

📗 3. Test Statistics

Z-Test (known σ, large n)

$$z = \frac{\bar{x} - \mu_0}{\sigma / \sqrt{n}}$$

T-Test (unknown σ, small n)

$$t = \frac{\bar{x} - \mu_0}{s / \sqrt{n}}$$

Proportion Z-Test

$$z = \frac{\hat{p} - p_0}{\sqrt{p_0(1 - p_0)/n}}$$

Chi-Square Test (Goodness of Fit or Independence)

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

📕 4. Types of Errors

Error Type	Meaning
Type I	Rejecting H_0 when it's true
Type II	Not rejecting H_0 when it's false

- Type I error probability = α
- Type II error probability = β

📒 5. One-Tailed vs. Two-Tailed Tests

Test Type	Alternative Hypothesis	Critical Region
One-tailed	$H_1 : \mu > \mu_0$	Right tail
One-tailed	$H_1 : \mu < \mu_0$	Left tail
Two-tailed	$H_1 : \mu \neq \mu_0$	Both tails

📓 6. p-value Interpretation

p-value	Decision (if $\alpha = 0.05$)
< 0.01	Strong evidence to reject H_0
$0.01 - 0.05$	Moderate evidence
≥ 0.05	Not significant (fail to reject)

📔 7. Common Tests Summary

Test Type	Used When
Z-Test	Known σ, large sample size
T-Test	Unknown σ, small sample size
Paired T-Test	Same subjects, before/after
Two-Sample T-Test	Two independent groups
Proportion Test	One or two proportions
Chi-Square Test	Categorical data (frequencies)
ANOVA	Comparing more than 2 group means