

**Vision of the Department**

To be a well-known centre for pursuing computer education through innovative pedagogy, value-based education and industry collaboration.

Mission of the Department

To establish learning ambience for ushering in computer engineering professionals in core and multidisciplinary area by developing Problem-solving skills through emerging technologies.

Session 2025-2026

Vision: Dream of Where you want	Mission: Means to achieve vision
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Program Educational Objectives of the program (PEO): (broad statements that describe the professional and career accomplishments)

PEO1	Preparation	P: Preparation	Pep-CL abbreviation pronounce as Pep-si-LL easy to recall
PEO2	Core Competence	E: Environment (Learning Environment)	
PEO3	Breadth		
PEO4	Professionalism	P: Professionalism	
PEO5	Learning	C: Core Competence	
	Environment	L: Breadth (Learning in diverse areas)	

Program Outcomes (PO): (statements that describe what a student should be able to do and know by

the end of a program) **Keywords of POs:**

Engineering knowledge, Problem analysis, Design/development of solutions, Conduct Investigations of Complex Problems, Engineering Tool Usage, The Engineer and The World, Ethics, Individual and Collaborative Team work, Communication, Project Management and Finance, Life-Long Learning

PSO Keywords: Cutting edge technologies, Research

"I am an engineer, and I know how to apply engineering knowledge to investigate, analyse and design solutions to complex problems using tools for entire world following all ethics in a collaborative way with proper management skills throughout my life." *to contribute to the development of cutting-edge technologies and Research.*

Integrity: I will adhere to the Laboratory Code of Conduct and ethics in its entirety.

Name and Signature of Student and Date

(Signature and Date in Handwritten)



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Session	2025-26(ODD)	Course Name	Lab : MFDA
Semester	5	Course Code	23IOT1526
RollNo	52	Name of Student	Parth Bhedurkar

Practical Number	8
Course Outcome	<ol style="list-style-type: none"> 1. <input type="checkbox"/> CO2: Apply non-parametric statistical tests to analyze data without assuming normal distribution. 2. <input type="checkbox"/> CO3: Perform the Sign Test to test hypotheses related to population medians. 3. <input type="checkbox"/> CO4: Interpret and conclude real-world problems using results from non-parametric hypothesis testing.
Aim	To implement Sign Test:
Problem Definition	A famous cookie manufacturer claims that their bags of chocolate chip cookies contain “more than 1100 chocolate chips on average”. A diligent group of students buys 16 bags of these cookies and counts the number of chocolate chips in each bag.
Theory (100 words)	<ul style="list-style-type: none"> <input type="checkbox"/> The Sign Test is a non-parametric statistical test used to determine whether there is a difference between the median of a sample and a claimed (hypothesized) value or between two related samples. It does not assume normal distribution of data, making it useful for small or non-normally distributed samples. <input type="checkbox"/> In this practical, the cookie manufacturer claims that the average number of chocolate chips per bag is more than 1100. The Sign Test helps determine whether the observed data provides sufficient evidence to support or reject this claim. <input type="checkbox"/> The test works by comparing each observation with the hypothesized median (here, 1100): <ul style="list-style-type: none"> • If the observation > 1100 → assign a ‘+’ sign • If the observation < 1100 → assign a ‘-’ sign • If equal to 1100 → it is ignored in the test <input type="checkbox"/> The number of positive and negative signs is then counted, and the smaller of the two counts is used as the test statistic.



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	<ul style="list-style-type: none"> <input type="checkbox"/> The test statistic is compared against the critical value from the binomial distribution (for small samples) or normal approximation (for large samples). <input type="checkbox"/> Decision Rule: <ul style="list-style-type: none"> • If the calculated value < critical value → Reject H₀ (evidence supports the claim). • Otherwise → Fail to reject H₀ (no sufficient evidence to support the claim).
Procedure and Execution (100 Words)	<p>Steps:</p> <ol style="list-style-type: none"> 1. Collect the sample data (number of chocolate chips in 16 bags). 2. Set up the hypotheses: <ul style="list-style-type: none"> o Null Hypothesis (H₀): Median number of chips = 1100 o Alternative Hypothesis (H₁): Median number of chips > 1100 3. For each sample value, compare it with 1100: <ul style="list-style-type: none"> o If greater → assign “+” o If smaller → assign “–” o If equal → ignore 4. Count the number of positive and negative signs. 5. Let n be the total number of non-zero differences (i.e., ignoring ties). 6. The test statistic (x) = smaller of the number of “+” and “–” signs. 7. Use the Binomial distribution with parameters (<i>n</i>, <i>p</i> = 0.5) to calculate the probability (p-value). 8. Compare p-value with significance level ($\alpha = 0.05$): <ul style="list-style-type: none"> o If $p < \alpha$ → Reject H₀ (evidence supports the claim). o Else → Fail to reject H₀ (no sufficient evidence).
	<p>Code:</p> <pre># Sample data (number of chocolate chips in each of 16 bags) chips <- c(1150, 1120, 1180, 1115, 1090, 1170, 1135, 1145, 1200, 1110, 1195, 1112, 1105, 1085, 1220, 1155) # Claimed median mu0 <- 1100 # Step 1: Compute signs (+ for >1100, - for <1100) signs <- chips - mu0 signs <- signs[signs != 0] # remove ties (exactly equal to 1100) # Step 2: Count how many are above and below 1100 n_pos <- sum(signs > 0)</pre>



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<pre>n_neg <- sum(signs < 0) n <- n_pos + n_neg cat("Number above 1100:", n_pos, "\n") cat("Number below 1100:", n_neg, "\n") cat("Effective sample size (excluding ties):", n, "\n\n") #Step 3: Perform one-sided binomial test (right-tailed) #Under H0, probability of + sign = 0.5 sign_test <- binom.test(n_pos, n, p = 0.5, alternative = "greater") #Step 4: Display result print(sign_test) #Step 5: Interpretation if(sign_test\$p.value < 0.05) {</pre>	
Output:	



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The screenshot shows two instances of RStudio running side-by-side on a Windows desktop. Both sessions have the same workspace and environment set up, with the same R script open in the editor.

R Script Content:

```
## Step 1: Compute signs (+ for >1100, - for <1100)
signs <- chips - mu0
signs[signs == 0] # remove ties (exactly equal to 1100)

## Step 2: Count how many are above and below 1100.
n_pos <- sum(signs > 0)
n_neg <- sum(signs < 0)
n <- n_pos + n_neg

## Step 3: Perform one-sided binomial test (right-tailed)
# Under H0, probability of + sign = 0.5
sign_test <- binom.test(n_pos, n, p = 0.5, alternative = "greater")

## Step 4: Display result
print(sign_test)
```

Session 1 Output (Top Window):

```
## Step 1: Compute signs (+ for >1100, - for <1100)
signs <- chips - mu0
signs[signs == 0] # remove ties (exactly equal to 1100)

## Step 2: Count how many are above and below 1100.
n_pos <- sum(signs > 0)
n_neg <- sum(signs < 0)
n <- n_pos + n_neg

## Step 3: Perform one-sided binomial test (right-tailed)
# Under H0, probability of + sign = 0.5
sign_test <- binom.test(n_pos, n, p = 0.5, alternative = "greater")

## Step 4: Display result
print(sign_test)
```

Session 2 Output (Bottom Window):

```
## Step 1: Compute signs (+ for >1100, - for <1100)
signs <- chips - mu0
signs[signs == 0] # remove ties (exactly equal to 1100)

## Step 2: Count how many are above and below 1100.
n_pos <- sum(signs > 0)
n_neg <- sum(signs < 0)
n <- n_pos + n_neg

## Step 3: Perform one-sided binomial test (right-tailed)
# Under H0, probability of + sign = 0.5
sign_test <- binom.test(n_pos, n, p = 0.5, alternative = "greater")

## Step 4: Display result
print(sign_test)
```



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The screenshot shows the RStudio interface with the following details:

- Script Editor:** The main window displays R code for a one-sided binomial test. The code includes sample data (chips), claimed median (μ_0), computation of signs, and counts of signs above and below 1100. It also calculates the effective sample size (n), and performs a one-sided binomial test under the null hypothesis.
- Console Output:** Below the script, the R console shows the same steps being run interactively, producing identical results.
- Environment:** A sidebar panel shows the current environment variables.
- Connections:** Another sidebar panel shows available connections.
- File Menu:** Includes File, Edit, Code, View, Plots, Session, Build, Debug, Profile, Tools, Help.
- Toolbar:** Includes icons for New, Open, Save, Run, Source, and other common functions.
- Bottom Bar:** Shows the operating system's taskbar with various application icons.

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	<p>The screenshot shows the RStudio interface. The left pane displays an R script named "Untitled1.R" with the following code:</p> <pre> 1 # Step 1: Create the contingency table 2 data <- matrix(c(35, 25, 20, 24), 3 nrow = 2, 4 byrow = TRUE) 5 6 # Add row and column names 7 rownames(data) <- c("Male", "Female") 8 colnames(data) <- c("Success_Yes", "Success_No") 9 10 # Display the contingency table 11 print("Contingency Table:") 12 print(data) 13 14 # Step 2: Perform chi-square test 15 test_result <- chisq.test(data) 16 17 # Step 3: Display test results 18 print("Chi-square Test Result:") 19 print(test_result) 20 21 </pre> <p>The right pane shows the "Environment" tab with variables defined:</p> <ul style="list-style-type: none"> ch1_test: List of 9 <ul style="list-style-type: none"> data: num [1:2, 1:2] 35 math_data: num [1:2, 1:2] 30 test_result: List of 9 <p>The "Console" tab shows the output of the R code:</p> <pre> R > R 4.5.1 - /- Male 35 25 Female 20 24 > # Step 2: Perform Chi-square test > test_result <- chisq.test(data) > # Step 3: Display test results > print("Chi-square Test Result:") [1] "Chi-square Test Result:" > print(test_result) Pearson's Chi-squared test with Yates' continuity correction </pre>
Output Analysis	<ol style="list-style-type: none"> 1. The Sign Test was performed to test whether the median number of chocolate chips per bag is greater than 1100. 2. Out of 16 observations, one value equaled 1100 and was ignored, leaving 15 valid comparisons. 3. The number of "+" signs (values > 1100) was 10, and the number of "-" signs (values < 1100) was 5. 4. Using a binomial test with $n = 15$ and $p = 0.5$, the p-value ≈ 0.15. 5. Since p-value > 0.05, we fail to reject the null hypothesis (H_0). 6. The result indicates that there is no significant evidence to support the manufacturer's claim that bags contain more than 1100 chocolate chips on average. 7. Therefore, the median number of chocolate chips is not significantly



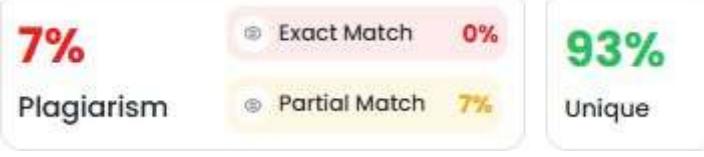
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	greater than 1100 based on the given sample.
Link of student Github profile where lab assignment has been uploaded	https://github.com/parthbhedurkar
Conclusion	The Sign Test result shows that there is no significant evidence to support the manufacturer's claim that the cookie bags contain more than 1100 chocolate chips on average . Hence, the median number of chips is not significantly greater than 1100 .
Plag Report (Similarity index < 12%)	
Date	03/11/2025