

ISBN: 978-93-88901-43-7

# TUTORIAL BOOK ON MATHEMATICAL AND STATISTICAL TECHNIQUES - II

DR. SHAILESH SHASHIKANT JADHAV

Handwritten mathematical notes on a green background, including:

- $x^2 + y^2 = 2$
- A graph of a sine wave labeled  $\sin \theta$ .
- The binomial expansion:  $(x+a)^2 = x^2 + 2ax + a^2$
- A right-angled triangle with sides  $a$ ,  $b$ ,  $c$  and angles  $\alpha$ ,  $\beta$ .
- The value of  $\pi \approx 3.1415$ .
- The formula for standard deviation:  $\sigma = \sqrt{\frac{\sum (x-m)^2}{n}}$
- A matrix  $S_3 = \begin{bmatrix} 1 & 0 & 0 \\ 1 & 0 & 1 \\ 0 & 0 & 1 \end{bmatrix}$ .
- The formula for the height of a triangle:  $h = \sqrt{a \times b}$ .
- The limit:  $\lim_{x \rightarrow 1} \frac{\cot x - 2}{2^{11} x^3}$ .
- The formula for the area of a triangle:  $\frac{A-C}{C}$ .
- The formula for the area of a circle:  $S_x = \frac{b \pm (a-c)}{\sqrt{2a}}$ .
- The formula for the area of a circle:  $S_x = 4 - 3y^2$ .
- The formula for the area of a circle:  $\int \frac{\sqrt{x+a^2}}{x} dx = 2.79$ .
- The formula for the area of a circle:  $(x+y)^2 = \left(\frac{y}{2}\right)^2$ .
- The formula for the area of a circle:  $y = \frac{\Delta x}{\Delta^2}$ .

**TUTORIAL BOOK ON  
MATHEMATICAL AND STATISTICAL TECHNIQUES - II**

**(ISBN: 978-93-88901-43-7)**

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*Bhumi Publishing*

**2023**

***First Edition: April, 2023***

***ISBN: 978-93-88901-43-7***



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Published by:

Bhumi Publishing,

Nigave Khalasa, Kolhapur 416207, Maharashtra, India

Website: [www.bhumipublishing.com](http://www.bhumipublishing.com)

E-mail: [bhumipublishing@gmail.com](mailto:bhumipublishing@gmail.com)

Book Available online at:

<https://www.bhumipublishing.com/book/>



## **PREFACE**

*It gives me a great pleasure to present this book on Mathematics & Statistical Technique for the students of F. Y. B. Com. This book is written as per revised syllabus of University of Mumbai from the academic year 2016-2017.*

*The book is consisted of plenty of practice examples which are beneficial for tutorial course for the students. Each chapter of this book is divided into subtopics for better understanding of problems. I hope that the students will find this book of great help. In spite of this, suggestion from students and readers are always welcome.*

*I express my gratitude to honorable Secretary, Shivai Shikshan Prasark Mandal, Adv. S. S. Kale and Vice secretary, Shivai Shikshan Prasark Mandal, Adv. V. S. Deshmukh. for encouragement to carry out this work. I also express my sincere thanks to Principle, Sundarrao More College of Arts, Commerce & Science, Dr. D. P. Raverkar for his valuable guidance. I am also thankful to Bhumi Publication for their efforts that they have taken to publish this book in time.*

**- Dr. Shailesh Shashikant Jadhav**

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## **STUDENT PROFILE**

1. **Name of the Student** :
  
2. **Contact number** :
  
3. **Address** :
  
  
  
  
  
  
  
  
  
  
4. **Email** :
  
  
  
  
  
  
  
  
  
  
5. **Blood group** :
  
  
  
  
  
  
  
  
  
  
6. **Remark of Teacher** :

**Signature of the Student**

**Signature of the Teacher**

## **1. FUNCTIONS**

### **1.1 Functions.**

**Ex.1.** If  $f(x) = \sqrt{5x^3 - x^2} + 2x + 5$ .

**Find  $f(2)$ ,  $f(-4)$ ,  $f(4)$ , if exists.**

**Ans.**

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**Ex.2. If  $f(x) = 4x^3 + 2x^2 + \frac{1}{x} + 3$ .**

**Find  $f(0)$ ,  $f(1)$ ,  $f(2)$ , if exists.**

**Ans.**



## **1.2. Demand and Supply**

**Ex.1.  $D = p^2 - 2p + 1$  and  $S = p^2 - 4p + 4$ ,**

**Where 'D' is demand function, 's' is supply function and 'p' is price. Find demand and supply when price  $p=3$ .**

**Ans.**

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**Ex.2. Find the demand when price is 4. The demand function is given by  $D = p^2 - 5p + 10$**

**Ans.**

**Ex.3. Find the equilibrium price and equilibrium point for the demand and supply as given below: is  $D = p^2 + 6p + 9$  and  $S = p^2 + 18p + 81$**

**Ans.**

**1.3. Cost and Revenue Functions.**

**Ex.1. If the total cost function is  $C = 2x^2+5x+1$ , where  $x$  is total number of items produced. Find total cost and average cost at  $x=15$ ,  $x=20$ .**

**Ans.**

**Ex.2. The demand function is given by  $D = p^3 + 2p + 3$ ,  $p$  is price. Find the total revenue when price is ₹ 4 per unit.**

**Ans.**

**Ex.3. If the total cost function is given by  $C = 30 + 5x - x^2$  and demand function is  $d = 225 - x + x^2$ . Obtain the total profit when the demand is  $x = 3$ .**

**Ans.**

**Ex.4. Find the total revenue, when price  $p=4$  and demand function is  $D= 300p-2p^3$ .**

**Ans.**

**Ex.5. If the price of the item is:**

**$P = 20 + 5x + 3x^2$ ,  $x$  is number of units demanded. Find the total revenue when  $x=3$ .**

**Ans.**



## **2. DERIVATIVE AND APPLICATIONS**

### **2.1. Rules for Differentiation**

**Ex.1.** If  $y = 4x^3 + 3x^2 - 5x + 6$ . Find  $\frac{dy}{dx}$

**Ans.**

**Ex.2.** If  $y = \frac{(x+2)(2x+5)}{\log x}$  . Find  $\frac{dy}{dx}$

**Ans.**

**Ex.3. If  $y = e^x \sin x$  . Find  $\frac{dy}{dx}$**

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**Ex.4. If  $y = x^3 + 6x^2 - \frac{1}{x}$ . Find  $\frac{dy}{dx}$ .**

**Ans.**

## **2.2. Second Order Derivative**

**Ex.1.** If  $y= 3x^3+ 2x^2+5x+1$ . Find  $\frac{d^2y}{dx^2}$ .

**Ans.**

**Ex.2. If  $y = 3^x + \log x + e^x$ . Find  $\frac{d^2y}{dx^2}$ .**

**Ans.**

### **2.3 Marginal Functions**

**Ex.1. Let  $D = 2p^2 + 3p + 4$  is the demand function. Find the marginal demand at  $p = 3$ .**

**Ans.**

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**Ex.2. Let D is demand function,  $D = 4p^2 - 3p - 1$ . Find price elasticity of demand at  $p=10$ .**

**Ans.**



## **2.4 Extreme Points**

**Ex.1. Obtain the extreme values for the function  $f(x) = x^3 - 10x^2 + 5x + 4$ .**

**Ans.**

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**Ex.2. Make two parts of 50 such that their product is maximum.**

**Ans.**

**Ex.3. Find the maximum and minimum for  $f(x) = x^3 + \frac{64}{x^3}$ .**

**Ans.**

### **3. INTEREST-SIMPLE AND COMPOUND**

#### **3.1 Simple Interest**

**Ex.1. If Ganesh invested ₹ 15000 at 9 % simple interest per annum in XYZ S.I.P. Find the amount he gets after 5 years.**

**Ans.**

**Ex.2. Find the amount which yield ₹ 3000 as a simple interest at 13% per annum in 5 years.**

**Ans.**

**Ex.3.If ₹ 12000 counts to ₹ 20000 with simple interest in 3 years, Calculate the rate of interest.**

**Ans.**

### **3.2 Compound Interest**

**Ex.1. Find the sum and compound interest, if ₹ 5500 deposited for 6 years at 11%,  
calculated on**

**i) annually,**

**ii) half yearly,**

**Ans.**

**iii) quarterly**

**iv) monthly.**

**Ans.**



**Ex.2. What principal will count compound interest of ₹ 1000 half yearly with 9% for 4 years?**

**Ans.**

#### **4. ANNUITY AND EMI**

##### **4.1 Ordinary Annuities.**

**Ex.1. Calculate the sum for the ordinary annuity with periodic payment of ₹ 3500 in 6 years with interest rate 10%. The cases are as follows:**

- i) annulay,**
- ii) half- Yearly.**

**Ans.**

**i) quarterly**

**ii) monthly**

**Ans.**

**Ex.2. Sanjay deposited for 3 years in annuity with interest rate 9% on half yearly basis. The sum he gains is 35234. Calculate the periodic payment.**

**Ans.**

#### **4.2. Equated Monthly Instalments**

**Ex.1. Leela borrowed ₹ 16576 at 10% per annum interest rate for 5 years. Find his equally monthly installment, if:**

- i) Flat interest rate,**
- ii) Interest on reducing balance.**

**Ans.**

**Ex.2. XYZ bank offer special scheme for customer. It gives 14 % interest per annum. If Sangita invested ₹ 15000 for each 3 months. What amount she collected after 4 years.**

**Ans.**

## 5. BIVARIATE LINEAR CORRELATION

### 5.1. Karl-pearson Coefficient of Correlation

**Ex.1. Explain the type of correlation and draw the scatter diagram for the data given below.**

X	5	6	8	7	9	10	11	12	13
Y	2	5	4	6	8	7	10	11	11

**Ans.**

**Ex.2. Calculate the Karl Pearson coefficient of correlation for the following data**

**i)**

<b>x</b>	<b>5</b>	<b>7</b>	<b>2</b>	<b>1</b>	<b>8</b>	<b>6</b>
<b>y</b>	<b>3</b>	<b>6</b>	<b>8</b>	<b>2</b>	<b>4</b>	<b>1</b>

**Ans.**



ii)

<b>x</b>	<b>9</b>	<b>12</b>	<b>14</b>	<b>16</b>	<b>18</b>	<b>16</b>
<b>y</b>	<b>16</b>	<b>12</b>	<b>10</b>	<b>11</b>	<b>8</b>	<b>6</b>

**Ans.**

**Ex.3. If  $\sum xy = 54$ ,  $\sum x^2 = 50$ ,  $\sum y^2 = 70$ ,  $\sum x = 120$ ,  $\sum y = 22$ ,  $n = 10$ .**

**Find Karl Pearson coefficient of correlation.**

**Ans.**

## 5.2. Spearman's Coefficient of Correlation

**Ex.1. Topmost marks of the 7 students of XYZ College in Mathematics and Accounts are given by:**

<b>Mathematics</b>	<b>75</b>	<b>90</b>	<b>80</b>	<b>70</b>	<b>75</b>	<b>86</b>	<b>81</b>
<b>Account</b>	<b>85</b>	<b>78</b>	<b>80</b>	<b>85</b>	<b>70</b>	<b>87</b>	<b>90</b>

**Find Spearman's coefficient of correlation.**

**Ans.**

**Ex.2. Find Spearman's coefficient of correlation for the following repeated rank**

<b>Grade 1</b>	B	A	A <sup>+</sup>	C	B <sup>+</sup>	B	O
<b>Grade 2</b>	D	O	C	A	A	O <sup>+</sup>	B

**Ans.**

**Ex.3. Find Spearman's coefficient of correlation for the following repeated rank**

<b>Marks</b>	<b>55</b>	<b>60</b>	<b>45</b>	<b>50</b>	<b>55</b>
<b>Grades</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>A</b>	<b>A</b>

**Ans.**

## **6. BIVARIATE LINEAR REGRESSION**

### **6.1. Formulae**

**Ex.1. Write down the formulae for arithmetic mean, variance and standard deviation.**

**Ans.**

**Ex.2. Write down the formulae for covariance, coefficient of correlation, coefficient of regression.**

**Ans.**

**Ex.3. Write down the formulae for coefficients of regression and equation of regression lines.**

**Ans.**



**6.2. Coefficients of Regression.**

**Ex.1. Find the arithmetic means and the variance for the following:**

<b>A</b>	<b>5</b>	<b>8</b>	<b>7</b>	<b>6</b>
<b>B</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>2</b>

**Ans.**

**Ex.2. Find the standard deviation and covariance for the following:**

<b>E</b>	<b>1</b>	<b>4</b>	<b>8</b>	<b>2</b>
<b>F</b>	<b>2</b>	<b>3</b>	<b>1</b>	<b>5</b>

**Ans.**

**Ex.3. Find the coefficient of correlation and coefficient of regression for the following:**

<b>M</b>	<b>11</b>	<b>8</b>	<b>7</b>	<b>6</b>	<b>5</b>
<b>N</b>	<b>1</b>	<b>2</b>	<b>5</b>	<b>8</b>	<b>9</b>

**Ans:**

**Ex.4. Find the both equations for the line of regression for the following table:**

<b>A</b>	<b>1</b>	<b>6</b>	<b>8</b>	<b>5</b>	<b>3</b>
<b>B</b>	<b>2</b>	<b>3</b>	<b>1</b>	<b>7</b>	<b>1</b>

**Ans.**

**Ex.5. For the following bivariate data:**

<b>A</b>	<b>1</b>	<b>6</b>	<b>8</b>	<b>5</b>	<b>3</b>
<b>B</b>	<b>2</b>	<b>3</b>	<b>1</b>	<b>7</b>	<b>1</b>

- i) Find the both equations for the line of regression,**
- ii) Find x, if y =4,**
- iii) Find y, if x =7.**

**Ans.**

**Ex.6. Two regression lines are as given below:**

**X on y :  $3x + 5y = 2$**

**Y on x :  $5x + y = 3$**

**Find  $\bar{y}$ ,  $\bar{x}$ ,  $b_{yx}$ ,  $b_{xy}$ .**

**Ans.**

**Ex.7. Find arithmetic means  $\bar{x}$  and  $\bar{y}$ , if regression lines are:**

$$(5.7)x - (4.3)y = 1 \quad \text{and} \quad (2.1)x + (1.3)y = 2$$

**Ans.**

## 7. TIME SERIES

### 7.1. Moving Averages

**Ex.1.** Calculate the three yearly moving averages of students of XYZ college. The academic year wise data is as given below. On one graph paper plot the original values along with trend values.

Year	1994	1995	1996	1997	1998	2000	2001	2002
No. of students	1500	1700	1800	1600	1900	1950	1850	1900

**Ans.**



**Ex.2. Calculate the five yearly moving averages of students of XYZ College. The academic year wise data is as given below. On one graph paper plot the original values along with trend values.**

<b>Year</b>	<b>1994</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>
<b>No. of students</b>	<b>1500</b>	<b>1700</b>	<b>1800</b>	<b>1600</b>	<b>1900</b>	<b>1950</b>	<b>1850</b>	<b>1900</b>

**Ans.**

**Ex.3. Use least square method to fit a linear trend for the data of XYZ Investment Company. Also estimate the trend values for 2020.**

<b>Year</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>
<b>Investment</b>	<b>85</b>	<b>80</b>	<b>94</b>	<b>115</b>	<b>130</b>	<b>137</b>	<b>160</b>

**Ans.**

**Ex.4. Fit a linear trend using least square method. Estimate value for 2005.**

<b>Year (X)</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>
<b>Value (Y)</b>	<b>15.5</b>	<b>23.4</b>	<b>20.9</b>	<b>25.2</b>	<b>12.3</b>

**Ans.**

**Ex.5. The index numbers with respective years is given in table below. Obtain the trend value using three yearly cycle.**

<b>Year (X)</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>
<b>Index Number(Y)</b>	<b>50</b>	<b>100</b>	<b>110</b>	<b>90</b>	<b>75</b>

**Ans.**

## 8. INDEX NUMBERS

### 8.1. Index Numbers

**Ex.1. Changes in the strength of students of different faculties of XYZ College in academic year 2020-21 and 2021-22 is given below. Find the index number with 2020 as base year.**

Year	B. Sc.	B. Com.	B. A.	B. C. S.	B. B. A.
2020-21	180	120	120	60	90
2021-22	180	125	100	90	100

**Ans.**

**Ex.2. Find the Index Numbers for following data.**

<b>Year</b>	<b>I</b>	<b>II</b>	<b>III</b>	<b>IV</b>	<b>V</b>	<b>VI</b>
<b>2015</b>	<b>70</b>	<b>40</b>	<b>110</b>	<b>100</b>	<b>55</b>	<b>60</b>
<b>2016</b>	<b>60</b>	<b>55</b>	<b>60</b>	<b>80</b>	<b>113</b>	<b>48</b>

**i) Use Simple Average of Relative Method**

**Ans.**

**ii) Use Simple Aggregative Method**

**Ans.**

## 8.2. Weighted Index Numbers

Ex.1. The following data represents faculty wise strength of students for XYZ college in academic year 2015-16 and 2016-17.

Faculty	Base year ( $p_0$ )	Current year ( $p_1$ )	Weightage ( $w$ )
B. Sc.	110	125	5
B. Com.	81	120	4
B. A.	60	80	3
B. C. S.	70	73	15
B. B. A.	50	60	10

i) Find the Weighted Average of Price Relative Index Number.

Ans.



**ii) Find Weighted Aggregative Index Number.**

**Ans.**

**Ex.2. Write down the following for Weighted Index Numbers.**

- i) Laspeyre's formula**
- ii) Paasche's formula**
- iii) The Drobish-Bowley formula**
- iv) The Fisher's Formula**

**Ans.**

**Ex.3. Find the Laspeyre's, and Paache's Weighted Index Numbers.**

Commodity	Current year		Base Year	
	P	Q	p	Q
E	12	8	30	6
F	11	6	10	7
G	8	2	9	8
H	35	4	8	8

**Ans.**

**Ex.4. Find the Drobish-Bowle'y and Fisher's Weighted Index Numbers.**

Commodity	Current year		Base Year	
	P	Q	p	q
I	10	5	20	3
II	15	4	10	2
III	20	2	30	2
IV	35	7	12	8

**Ans.**

**Ex.5. Find the Marshall-Edgeworth's Weighted Index Numbers for the following data:**

Commodity	Current year		Base Year	
	P	Q	p	q
I	23	6	25	4
II	25	4	15	2
III	30	2	20	1
IV	40	5	12	5

**Ans.**

### **8.3. Chain Base Index Numbers**

**Ex.1. The prices of some items for the years 2016 to 2019 are as given below. Find the chain-based index numbers.**

<b>Year</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>
<b>Prices</b>	<b>15</b>	<b>14</b>	<b>20</b>	<b>17</b>

**Ans.**

**Ex.2. Change the following Fixed Base Index Numbers to Chain Base Index Numbers.**

<b>Year</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>
<b>Index Numbers (Base year-2010)</b>	<b>55</b>	<b>60</b>	<b>65</b>	<b>90</b>	<b>125</b>	<b>130</b>	<b>155</b>

**Ans.**

**Ex.3. Shift the base year to 2022 for the following.**

<b>Year</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>	<b>2020</b>
<b>Index Numbers (Base year-2014)</b>	<b>132</b>	<b>110</b>	<b>70</b>	<b>90</b>	<b>125</b>	<b>100</b>	<b>130</b>

**Ans.**



**Ex.4. Find the Cost of Living Index Numbers for the student's data given below.**

Groups	Base Year 2010		Current Year 2016
	$P_0$	$q_0$	$p_1$
Transport	50	12	55
Admission fee	12	6	14
Examination fee	8	7	8
Cloths (Uniform)	7	4	9
Miscellaneous	10	5	8

**Ans.**

## **9. BINOMIAL AND POISSON DISTRIBUTION**

### **9.1. Binomial Distribution**

**Ex.1. Consider the random experiment of tossing 5 coins, Find the probability of getting:**

- i) 2 heads,**
- ii) atmost 3 heads,**

**Ans.**

- i) at least 5 heads,**
- ii) exactly 1 tails.**

**Ans.**

## **9.2. Mean and Variance of Binomial Distribution**

**Ex.1. Find mean and variance of Binomial Distribution if:**

- i)  $P=0.5$ ,  $n= 55$**
- ii)  $P=0.8$ ,  $n= 115$**

**Ans.**

**Ex.2. If mean = 8 and standard deviation = 3. Find  $p$  and  $n$ .**

**Ans.**

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**Ex.3. If variance = 5.8 and mean = 16. Find n and p.**

**Ans.**

**Ex.4. Consider the experiment of throwing 2 dice simultaneously. Find the probability that sum on the uppermost face is at least 5.**

**Ans.**

## **9.2. Poisson Distribution**

**Ex.1. Consider the Poisson Distribution with  $\lambda = 0.5$ , find:**

- i)  $p(x = 5)$**
- ii)  $p(x \leq 4)$**
- iii)  $p(0)$**
- iv)  $p(x \geq 4)$ .**

**Ans.**



**Ex.2. If following satisfies for random variable:**

- i)  $p(2) = p(6)$**
- ii) random variable follows Poisson distribution**

**Find variance and mean.**

**Ans.**

## **10. NORMAL PROBABILITY DISTRIBUTION**

### **10.1 Normal Distribution**

**Ex.1. Consider the standard normal variate X, find the area between:**

- i) X= -1.5 to X=2,**
- ii) X= 0 to X=2,**
- iii) area to the right of X=2.**

**Ans.**

- i) between  $X= 0.8$  and  $x =1.5$ ,**
- ii) left to the  $X=- 1.23$ .**

**Ans.**

**Ex.2. If variable  $Y$  distributed normally with mean 45 and standard deviation 8.**

**Describe neat diagram for area under the graph of function  $g(x)$ , for:**

**i)      ( $48 < Y < 55$ )**

**ii)     ( $45 < Y < 58$ )**

**Ans.**

- i)  $(Y > 55)$
- ii)  $(Y < 55)$

**Ans.**

**Ex 3. The monthly required commodities of 1780 families of XYZ village are distributed normally. The standard deviation is ₹135 and mean is ₹5000. Calculate the number of families whose monthly required commodities will be**

- i) between ₹ 4000 and ₹ 7000,**
- ii) more than ₹ 5000.**

**Ans.**

**III) less than ₹ 4000**

**IV) between ₹ 3000 and ₹ 6000.**

**Ans.**

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**NOTES**



**TUTORIAL BOOK ON  
MATHEMATICAL AND STATISTICAL TECHNIQUES - II  
(ISBN: 978-93-88901-43-7)**

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