UNIT - 3

Hypothesis Testing

Estimation :- studying the samples & drawing the conclusion about population is known as estimation. There are 2 types of estimations.

1) point estimation
2) Interval estimation.

Point estimation :- By studying the single observation and drawing the conclusion about population is known as point estimation.

Interval estimation :- By studying the set of observation & drawing the conclusion about the population is known as interval estimation.

Procedure for statistical testing

Steps for Hypothesis testing

1) Null hypothesis (H_0) :-
prepare the assumptions to the problems without any favorism.

2) Alternative Hypothesis (H_1) :-
The converse of null hypothesis is known as alternative hypothesis

3) If the alternative hypothesis contains not equality ($\neq$) sign then the name of the test is known as two tailed test.

4) If the alternative hypothesis contains inequality sign then the test is known as single tailed test.

5) If the inequality is less than (<) then it is known as left single tailed test.

6) If the inequality sign is greater than (>) then it is known as right single tailed test

⇒ **Degrees of freedom (d.f):-**

The no. of observations that are actually participating for testing the hypothesis is known as degrees of freedom.

Ex:- If the no. of observations are n, its degrees of freedom is $n-1$.

→ **Types of test:-**

~~1) Sampl~~

1) Small sample test

2) large sample test

1) If no. of obs in given data are ≤ 30 then it is known as small sample test and is defined as

$$t = \underbrace{\frac{x - E(x)}{S.E(x)}}_{\text{Calculated part}} \sim \underbrace{t_{n-1}}_{\text{tabulated part}}$$

S.E - Standard Error.

2) If no. of samples (n) > 30 then it is known as large sample test & is defined as

$$z = \frac{x - E(x)}{S.d(x)} \sim N(0,1)$$

⇒ **Levels of Significance (LOS):-**

There are 4 diff accepting levels for testing the hypothesis. Those are:-

90% 95% 98% 99%

The rejection levels are

10% 5% 2% 1%

* levels of significance mathematically denoted by t value.

4) Inference :- / (conclusion)

Since the calculated value is less than tabulated value at diff LOS in diff d.f, our null hypothesis will be accepted, otherwise rejected.

1) Statistical Errors :- (Types of errors)

Type I Error :-

Rejecting H_0 when H_0 is true.

Rej H_0 | H_0 is true

It is denoted by α

2) Type II Error :-

Accepting H_0 when H_0 is false

Accep H_0 | H_0 is false

It is denoted by β

Notation

	Population	Sample
Size	N	n
Mean	μ	$\bar{x} = \frac{\sum x_i}{n}$
Variance	σ^2	$S^2 = \frac{\sum (x_i - \bar{x})^2}{n-1}$
Proportion	P	$p = x/n$

$S.d = \sqrt{\text{Population variance}}$

$S.E = \sqrt{\text{Sample variance}}$

Types of tests

chisquare test (χ^2- test)

There are two types of chisquare tests

1) chisquare goodness of fit for 'independent attributes

2) chisquare goodness of fit for "r×c tables"

1) $H_0: P_1 = P_2 = \dots = P_n$

$H_1: P_1 \neq P_2 \neq \dots \neq P_n$

d.f : $n-1$

Los : at diff levels

Test statistics :-

$$\chi^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i} \sim \chi^2_{n-1}$$

O - observed frequencies

E - expected frequencies / estimated values

Sample table :-

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

The total of last column itself is calculated value

Inference

Since χ^2 calculated value < χ^2 table value at diff Los in diff d.f, our null hypothesis will be accepted otherwise rejected.

χ^2- test ($r \times c$ tables)

$H_0: P_1 = P_2 = P_3 = \ldots = P_n$

$H_1: P_1 \neq P_2 \neq P_3 \neq \ldots \neq P_n$

d.f : $(r-1 \times c-1)$ r = no. of rows, c = no. of columns

LOS: at different levels

Test statistics:-

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i} \underset{\text{follows}}{\sim} \chi^2_{(r-1 \times c-1)}$$

Inference:-

If χ^2 calculated value is less than χ^2 tabulated value, our null hypothesis will be accepted otherwise rejected.

2x2 contigency table:-

	α	β	R.T
I	a	b	a+b
II	c	d	c+d
C.T	a+c	b+d	N = a+b+c+d

$$E(a) = \frac{C.T \times R.T}{N} = \frac{(a+b)(a+c)}{N}$$

$$E(b) = \frac{(a+b)(b+d)}{N}$$

$$E(c) = (a+c)(c+d) / N$$

$$E(d) = (c+d)(b+d) / N$$

	O	E	$(O-E)^2$	$\frac{(O-E)^2}{E}$
a				
b				
c				
d				

Test the χ^2 goodness of fit for following data comment the data at 5% LOS

	α	β	R.T
A	18	26	44
B	45	52	97
C.T	63	78	N = 141

$H_0 : P_1 = P_2 = P_3 = P_4$

$H_1 : P_1 \neq P_2 \neq P_3 \neq P_4$

d.f : $r = 2$: $c = 2$

d.f $= (2-1)(2-1) = 1$

LOS : 0.05

Test statistics :-

$$\chi^2 = \Sigma \frac{(O-E)^2}{E} \sim (r-1)(c-1)$$

$E(a) = \frac{44 \times \cancel{78}\,63}{141} = 19.65$

$E(b) = \frac{44 \times 78}{141} = 24.34$

$E(c) = \frac{63 \times 97}{141} = 43.34$

$E(d) = \frac{97 \times 78}{141} = 53.65$

i.e., There is no significant differences b/w the population porportion

O	E	$(O-E)^2$	$\frac{(O-E)^2}{E}$
a	19.65	2.7225	0.1385
b	24.34	2.7556	0.1132
c	43.34	2.7556	0.0635
d	53.65	2.7225	0.0507
			0.3659

$\chi^2_{cal} = \Sigma \frac{(O-E)^2}{E} = 0.3659$

$\chi^2_{table} = 3.84$ at 5% LOS in 1 d.f

since $\chi^2_{cal} < \chi^2_{table}$ in 1 d.f at 0.05 LOS

∴ our null hypothesis will be accepted

2) Test χ^2 goodness of fit for following data

	A	B	C	D
α	17	21	18	130
β	15	40	26	35
γ	11	25	35	43

$d.f = (3-1)(4-1)$
$= 2\times 3 = 6$

$H_0: P_\alpha = P_\beta = P_\gamma = P_A = P_B = P_C = P_D$
$H_1: P_\alpha \neq P_\beta \neq P_\gamma \neq P_A \neq P_B \neq P_C \neq P_D$

LOS: $= 5\% = 0.05$

Test statistics

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i} \sim \chi^2_{(c-1)(r-1)}$$

~~$E(\alpha)$~~ =

	A	B	C	D	
α	17	21	18	130	86
β	15	40	26	35	116
γ	11	25	35	43	114
	43	86	79	108	316

$E(17) = \frac{43\times 86}{316} = 11.702$

$E(15) = \frac{116\times 43}{316} = 15.784$

$E(11) = \frac{114\times 43}{316} = 15.512$

$E(21) = \frac{86\times 86}{316} = 23.405$

$E(18) = \frac{86\times 79}{316} = 21.5$

$E(30) = \frac{86\times 108}{316} = 29.392$

$E(40) = \frac{116\times 86}{316} = 31.56$

$E(26) = \frac{79\times 116}{316} = 29$

$E(35) = \frac{79\times 114}{316} = 39.645$

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$E(25) = 31.025$

$E(35) = \frac{114 \times 79}{316} = 28.5$

$E(43) = \frac{114 \times 108}{316} = 38.962$

O	E	$(O-E)^2$	$\frac{(O-E)^2}{E}$
17	11.702	28.068	2.398
21	23.405	5.784	0.247
18	21.5	12.25	0.569
30	29.392	0.369	0.012
15	15.784	0.614	0.038
40	31.56	71.233	2.257
26	29	9	0.310
35	39.645	21.576	0.544
11	15.512	20.358	1.312
25	31.025	36.300	1.170
35	28.5	42.25	1.482
43	38.962	16.305	0.418
			10.757

$\chi^2_{cal} = 10.757$

$\chi^2_{tab} = 12.59$ at 5% LOS in 6 d.f

Since $\chi^2_{cal} < \chi^2_{tab}$ in 6 d.f at 0.05 LOS

our null hypothesis will be accepted

3) A die is rolled 120 times. check whether the die is unbiased or not for the following data.

face	1	2	3	4	5	6
freq	35	40	30	25	40	30

→ Avg of given data is expected frequency

H_0 : die is unbaised

H_1 : die is not unbaised

d.f : $n=6$

$\Rightarrow$ d.f : 5

LOS : 5% = 0.05

Test statistics :-

$$\chi^2 = \Sigma \frac{(O-E)^2}{E} \sim \chi^2_{n-1}$$

Calculation

$$Exp = \frac{\Sigma fi}{n} = \frac{\Sigma O}{n}$$

$$= \frac{200}{6} = 33.3$$

For every obs value, exp value is same

O	E	$(O-E)^2$	$\frac{(O-E)^2}{E}$
35	33.3	2.89	0.086
40	"	44.89	1.348
30	"	10.89	0.327
25	"	68.89	2.068
40	"	44.89	1.348
30	"	10.89	~~1.348~~ 0.327
			5.504.

$$\chi^2_{cal} = 5.504$$

$$\chi^2_{tab} = 11.07$$

since $\chi^2_{cal} < \chi^2_{tab}$ at 5 d.f in 0.05 LOS

Our null hypothesis will be accepted

i.e., the die is unbiased

Testing Single sample mean (σ unknown)

[Small sample test]

$H_0 : \bar{x} = \mu$

$H_1 : \bar{x} \neq \mu$

d.f : $n-1$

LOS : at different levels

Here $\bar{x} = \frac{\sum x_i}{n}$

$s^2 = \frac{\sum(x_i - \bar{x})^2}{n-1}$

$\downarrow$ Sum of squares deviation from mean

Test statistics:

$$t = \frac{\bar{x} - \mu}{\sqrt{s^2/n}} \overset{df}{\sim} t_{n-1}$$

Inference :-

Since t calculated value $<$ t tabulated value at different LOS in different d.f, our null hypothesis will be accepted, otherwise rejected.

Testing difference b/w two means (σ unknown)

$H_0 : \mu_1 = \mu_2 \; ; \; \sigma_1^2 = \sigma_2^2$

$H_1 : \mu_1 \neq \mu_2 \quad \sigma_1^2 \neq \sigma_2^2$

d.f : $n_1 - 1 + n_2 - 1$

$= n_1 + n_2 - 2$

LOS : at different levels

Test Statistics :-

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{s^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \sim t_{n_1+n_2-2}$$

Here $\bar{x}_1 = \frac{\sum x_{1i}}{n}$

$\bar{x}_2 = \frac{\sum x_{2i}}{n}$

$s^2 = \frac{\sum(x_{1i} - \bar{x}_1)^2 + \sum(x_{2j} - \bar{x}_2)^2}{n_1 + n_2 - 2}$ $\rightarrow$ pooled sample variance

Inference :- Since $t_{cal} < t_{tab}$ at diff LOS in diff d.f our null hypothesis will be accepted, otherwise rejected.

Equality of population Variances (F-test)

$H_0 : \sigma_1^2 = \sigma_2^2$

$H_1 : \sigma_1^2 \neq \sigma_2^2$

d.f : $F(n_1-1, n_2-1)$

LOS : at different levels

Test statistics :-

$$F = \frac{s_1^2}{s_2^2} \sim F$$

$$s_1^2 = \frac{\sum(x_{1i}-\bar{x}_1)^2}{n_1-1}, \quad s_2^2 = \frac{\sum(x_{2j}-\bar{x}_2)^2}{n_2-1}$$

Inference :- Since $F_{cal} < F_{tab}$ at diff LOS in diff d.f, our null hypothesis will be accepted, otherwise rejected.

1) The average life time of computer is 1200 hours. A random sample of 10 computers are tested whose averages are 1050, 1175, 1205, 1210, 1100, 1150, 1163, 1210, 1100, 1109

$H_0 : \mu = 1200$

$H_1 : \mu \neq 1200$

d.f : $n = 10$

$n-1 = 9$

LOS : 5%

$\bar{x} = \frac{11472}{10}$

$= 1147.2$

x_i	$(x_i-\bar{x})^2$
1050	9447.84
1175	772.84
1205	3340.84
1210	3943.84
1100	2227.84
1150	7.84
1163	249.64
1210	3943.84
1100	2227.84
1109	1459.24
	27621.6

$$s^2 = \frac{27621.6}{9} = 3069.066$$

$$t = \frac{\bar{x} - \mu}{\sqrt{s^2/n}} \sim t_{n-1}$$

$s = 55.399$

$s/\sqrt{n} = 17.518$

$$= \frac{-52.8}{17.518}$$

$$t = \frac{\bar{x} - \mu}{s/\sqrt{n}} = \frac{-52.8}{17.518} = -3.014$$

$\therefore |t_{cal}| = 3.014$

$t_{tab} = 2.262$

$t_{cal} > t_{tab}$

Inference :-

Since $t_{cal} < t_{tab}$ at 9 d.f our null hypothesis will be rejected

$\therefore$ Avarge life of computer $\neq$ 1200

2) The mean life expectancy is 59 years in the year 1980. A random sample of 12 people are observed whose mean lifes are 58, 57, 62, 61, 60, 59, 64, 55, 56, 56, 57, 61

$H_0 : \mu = 59$

$H_1 : \mu \neq 59$

$d.f = 11$

$$\bar{x} = \frac{706}{12} = 58.83$$

$$t = \frac{-0.17}{\sqrt{\frac{85.6668}{12}}} = \frac{-0.17}{2.67} = -0.063$$

$|t_{cal}| = 0.063$

58	0.6889
57	3.3489
62	10.0489
61	4.7089
60	1.3689
59	0.0289
64	26.7289
55	14.6689
56	8.0089
56	8.0089
57	3.3489
61	4.7089
706	85.6668

$t_{tab} = 2.201$

$t_{cal} < t_{tab}$

Inference :-

Q) Test the equality of means & equality of variances for the following observations & comment at 5% LOS

x_1	1	7	9	11	19	26	35
x_2	15	22	33	40	42	51	58

$H_0 : \mu_1 = \mu_2 \; ; \; \sigma_1^2 = \sigma_2^2$

$H_1 : \mu_1 \neq \mu_2 \; : \; \sigma_1^2 \neq \sigma_2^2$

d.f $\left.\begin{matrix} n_1 = 7 \\ n_2 = 7 \end{matrix}\right\} t_{n_1+n_2-2} = t_{12}$

~~i.e 12 d.f~~

$F(\nu_1, \nu_2) = F(n_1 - 1, n_2 - 1) = F(6, 6)$

LOS : 5%

Test statistics :-

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{s^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \overset{df}{\sim} t_{n_1+n_2-2}$$

$$F = \frac{s_1^2}{s_2^2} \sim F(\nu_1, \nu_2)$$

Calculation

x_{1i}	x_{2i}	$(x_{1i} - \bar{x}_1)^2$	$(x_{2i} - \bar{x}_2)^2$
1	15	207.93	496.3984
7	22	70.8964	233.4784
9	33	41.2164	18.3184
11	40	19.53	7.3984
19	42	12.81	22.2784
26	51	111.93	188.2384
35	58	383.37	429.3184
108	261	847.68	1395.4288

$\bar{x}_1 = 15.42$

$\bar{x}_2 = 37.28$

$$s_1^2 = \frac{847.68}{6} = 141.28$$

$$s_2^2 = \frac{1395.4288}{6} = 232.57$$

$$F = \frac{232.57}{141.28} = 1.646$$

$F_{cal} = 1.646$ $\quad$ $F_{tab} = 4.28$

$$s^2 = \frac{847.68 + 1395.4288}{12} = 186.92$$

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{s^2\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}} = \frac{-21.86}{7.307} = 2.99$$

$t_{cal} = 2.99$ $\quad$ $t_{tab} = 2.179$

$t_{cal} > t_{tab}$ $\quad$ $F_{cal} < F_{tab}$

Inference for mean :-

Since $t_{cal} > t_{tab}$ at 12 d.f in 0.05 LOS our null hypothesis will be rejected i.e., there is Significant differences b/w population mean

Inference for F :-

Since $F_{cal} < F_{tab}$ at $(6,6)$ d.f in ~~0.05~~ LOS our null hypothesis will be accepted. i.e., there is no significant differences b/w population variances.

Q) Test the equality of means & equality of variances for the following observations

x_1	11	15	21	28	32	40	46	58	
x_2	21	18	26	3	11	17	19	21	28

$H_0 : \mu_1 = \mu_2 \; : \; \sigma_1^2 = \sigma_2^2$

$H_1 : \mu_1 \neq \mu_2 \; : \; \sigma_1^2 \neq \sigma_2^2$

d.f : $\left.\begin{array}{l} n_1 = 8 \\ n_2 = 9 \end{array}\right\} t_{n_1+n_2-2} = t_{15}$

$F(\nu_1, \nu_2) = F(n_1-1, n_2-1) = F(8-1, 9-1) = F(7,8)$

LOS : 5%

Test statistics :-

x_{1i}	x_{2i}	$(x_{1i}-\bar{x}_1)^2$	$(x_{2j}-\bar{x}_2)^2$
11	21	415.14	7.72
15	18	268.14	0.048
21	26	107.64	60.52
28	3	11.39	231.648
32	11	0.39	52.128
40	17	74.39	1.488
46	19	213.89	0.608
58	21	708.89	7.728
	28		95.64
251	164	1799.87	457.52

$\bar{x}_1 = \frac{251}{8} = 31.375$

$\bar{x}_2 = \frac{164}{9} = 18.22$

$s_1^2 = 257.124$

$s_2^2 = \frac{457.52}{8} = 57.19$

$F_{cal} = \frac{257.124}{57.19} = 4.495 \qquad F_{tab}(7,8) = 3.50$

$s^2 = \frac{1799.87 + 457.52}{15} = 150.492$

$t_{cal} = \frac{13.155}{5.966} = \cancel{5.966}\ 2.2042$

Inference for mean:- $\qquad t_{tab} = 2.131$

Since $t_{cal} \geq t_{tab}$ in 15 d.f at 5% LOS, our null hypothesis will be ~~accepted~~ rejected, i.e., there is ~~no~~ significant diff b/w population means.

Inference for variance :-

Since $F_{cal} > F_{tab}$ at $(7,8)$ d.f in 5% LOS, our null hypothesis will be rejected. i.e., there is a significant diff b/w population variances

ANOVA (Analysis of Variance)

One way classification

Testing the consistency between the observations among the heterogenity groups is known as analysis of variance.

$$\text{Treatment} \left\{ \begin{array}{llllll} T_1 & a_{11} & a_{12} & a_{13} & a_{14} & \\ T_2 & a_{21} & a_{22} & a_{23} & a_{24} & a_{25} \\ T_3 & a_{31} & a_{32} & & & \\ T_4 & a_{41} & a_{42} & a_{43} & & \end{array} \right.$$

Calculation

$$c.f = \frac{G^2}{n}$$

Total sum of squares (TSS) = $\sum\sum y_{ij}^2 - c.f$

Treatment sum of squares (T_rSS) = $\frac{(\sum y_i)^2}{r} - c.f$

Error sum of squares (ESS) = TSS − T_rSS

ANOVA table

S.V	df	S.S	MSS	Fcal	Ftab
Treatment	$k-1$	TrSS	$M_{Tr} = \frac{TrSS}{k-1}$	$F = \frac{M_{Tr}}{M_E}$	$F(k-1, n-k)$
Error	$n-k$	ESS	$M_E = \frac{ESS}{n-k}$		
Total	$n-1$	TSS			

Q)

T_1	7	11	17	18	21		74
T_2	8	6	3	2	6	8	33
T_3	4	2	1	8			15
T_4	3	6	11	17	15		52
T_5	5	4	0	3			12
T_6	2	1					3
	29	30	32	48	42	8	189

$$C.f = \frac{G^2}{n} = \frac{(189)^2}{26} = 1373.88$$

$$T_{ss} = 2257 - 1373.88 = 883.12$$

$$T_{rss} = \frac{9647}{6} - 1373.88 = 1607.833 - 1373.88$$
$$= 233.95$$

$$E_{ss} = 883.12 - 233.95 = 649.17$$

ANNOVA table

S.V	d.f	SS	MSS	Fcal	Ftab
Treat	6-1=5	233.95	$\frac{233.95}{5} = 46.79$	$\frac{46.79}{32.45} = 1.44$	$F(5,20) = 2.71$
Error	26-6=20	649.17	$\frac{649.17}{20} = 32.45$		
Total	26-1=25	833.12			

Inference :- Fcal $\ngtr$ Ftab at (5,20) d.f in 0.05 LOS, our null hypothesis will be rejected.
i.e., there is a significant diff b/w the treatments

Q)

T_1	3	7	9	-1	6	24
T_2	2	3	0	4		9
T_3	5	4	2	8	6	25
T_4	2	1	-1	-2	0	0
T_5	2	1	0	1		4
						62

$n = 23$

$$C.F = \frac{(62)^2}{23} = 167.13$$

$$T_{SS} = 366 - 167.13 = 198.87$$

$$T_{rSS} = \frac{(24)^2}{5} = 115.2$$

$$t_{rSS} = \frac{9^2}{4} = 20.25$$

$$T_{rSS} = 125$$

$$T_{rSS} = 0$$

$$T_{rSS} = 4.$$

$$T_{rSS} = 264.45 - 167.13 = 97.32$$

$$E_{SS} = 198.87 - 97.32 = 101.55$$

Annova table

S.V	d.f	SS	MSS	Fcal	Ftab
treat	5-1=4	97.32	24.33	4.313	$F(4, 18) = 2.93$
Error	23-5=18	101.55 ~~5.64~~	5.64		
Total	22	198.87			

<u>Inference</u>:- Fcal > Ftab at F(4, 18) d.f in 0.05 LoS, our null hypothesis will be rejected.
i.e, there is a significant diff b/w the treatments.

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Paired t-test (small sample test)

Assumptions :-

1) population SD is unknown
2) observations need not be independent for both the samples.
3) The size of the observations of both the samples must be same.

$H_0 : \mu_1 = \mu_2$

$H_1 : \mu_1 \neq \mu_2$

d.f : n-1

LOS : at diff levels

Test statistics:-

$$t = \frac{\bar{d}}{S/\sqrt{n}} \sim t_{n-1}$$

Here $d_i = x_i - y_i$

$\bar{d} = \frac{\Sigma d_i}{n}$ $\quad S = \sqrt{\frac{\Sigma(d_i - \bar{d})^2}{n-1}}$

Inference :-

Since $t_{cal} < t_{tab}$ at diff LOS in diff d.f our null hypothesis will be ~~rejected~~. accepted otherwise rejected.

2) Apply paired t-test for the following set of observations and test the significance b/w the population.

x	7	9	17	26	35	42	51
y	9	8	16	24	39	45	60

n=7

d.f = 6

x	y	d_i	$(d_i-\bar{d})^2$
7	9	-2	0
9	8	1	9
17	16	1	9
26	24	2	16
35	39	-4	4
42	45	-3	1
51	60	-9	49
		-14	88

$S = \sqrt{\frac{88}{6}} = 3.829$

$\bar{d} = \frac{-14}{7} = -2$

$t_{cal} = \frac{-2}{3.829/\sqrt{7}} = \frac{-5.29}{3.829} = -1.381$

$|t_{cal}| = 1.381$

$t_{tab} = 2.447$

Inference :-

since $t_{cal} < t_{tab}$ at 0.05 LOS in 6 d.f

our null hypothesis will be accepted.

Q)

x	y	$d_i = x_i - y_i$	$(d_i-\bar{d})^2$
21	30	-9	64
35	42	-7	36
46	51	-5	16
57	56	1	4
84	52	32	1089
93	100	-7	36
102	110	-8	49
110	115	-5	16
		-8	1310

$n = 8$

$d.f = 7$

$\bar{d} = \frac{-8}{8} = -1$

$S = \sqrt{\frac{1310}{7}} = 13.68$

$t = \frac{-1 \times \sqrt{8}}{13.68} = -0.206$

$|t| = 0.206$

Inference :-

$t_{tab} = 2.365$

Since $t_{cal} < t_{tab}$ at 5% LOS in 7 d.f, our null hyp will be accepted