LATIN SQUARE :

) An agriculturist wants to test the effects of four different fertilizers A, B, c and D on the yield of paddy. In order to eliminate sources of error due to variability in soly-fertility he used the fertilizers in a Latin square arrangements given below where the numbers indicate yields in quintals per unit area. perform an analysis of variance to decide whether there is a difference between the fertilizers at 5% level of significance.

$$A_{12} 18 \quad D_{20} 21 \quad C_{16} 23 \quad B_{10} 11$$
$$D_{18} 22 \quad A_{14} 20 \quad B_{11} 10 \quad C_{14} 19$$
$$B_{12} 15 \quad C_{15} 21 \quad D_{19} 25 \quad A_{13} 17$$
$$C_{16} 22 \quad B_{11} 12 \quad A_{15} 15 \quad D_{20} 24$$

Soln: Let Origin $= x_{ij} - 18$. avs(min,max)

	x_1	x_2	x_3	x_4	total	x_1^2	x_2^2	x_3^2	x_4^2
y_1	0	3	5	-7	1	0	9	25	49
y_2	4	+2	-8	1	-1	16	4	64	1
y_3	-3	3	7	-1	6	9	9	49	1
y_4	4	-6	-3	6	1	16	36	9	36
total	5	2	1	-1	7	41	58	147	87
	Σx_1	Σx_2	Σx_3	Σx_4		Σx_1^2	Σx_2^2	Σx_3^2	Σx_4^2

step 1: Formulate H_0 & H_1:

H_0: There is no difference between the fertilizers

H_1: There is difference between the fertilizers.

step 2: To find T & N:

$$T = \Sigma n_1 + \Sigma n_2 + \Sigma n_3 + \Sigma n_4.$$

$$= 5 + 2 + 1 - 1 = 7$$

$$N = n_1 + n_2 + n_3 + n_4$$

$$= 4 + 4 + 4 + 4 = 16$$

step 3: To find correction factor, $C.F$.

$$C.F = \frac{T^2}{N} = \frac{49}{16} = 3.0625$$

step 4: To find TSS:

$$TSS = \Sigma n_1^2 + \Sigma n_2^2 + \Sigma n_3^2 + \Sigma n_4^2 - CF$$

$$= 41 + 58 + 147 + 87 - 3.0625$$

$$= 333 - 3.0625 = 329.94$$

step 5: To find SSC, SSR, & SST

$$SSC = \frac{(\Sigma n_1)^2}{n_1} + \frac{(\Sigma n_2)^2}{n_2} + \frac{(\Sigma n_3)^2}{n_3} + \frac{(\Sigma n_4)^2}{n_4} - C.F$$

$$= \frac{5^2}{4} + \frac{2^2}{4} + \frac{1^2}{4} + \frac{-1^2}{4} - 3.0625$$

$$= 4.6875$$

$$SSR = \frac{(\Sigma y_1)^2}{n_1'} + \frac{(\Sigma y_2)^2}{n_2'} + \frac{(\Sigma y_3)^2}{n_3'} + \frac{(\Sigma y_4)^2}{n_4'} - C.F$$

$$= \frac{1^2}{4} + \frac{-1^2}{4} + \frac{6^2}{4} + \frac{1^2}{4} - 3.0625$$

$$= 6.6875$$

To find SST :

A	0	2	-3	-1	-2 : Σz_1
B	-3	-6	-8	-7	-24 : Σz_2
C	4	3	5	1	13 : Σz_3
D	4	3	7	6	20 Σz_4

$$SST = \frac{(\Sigma z_1)^2}{4} + \frac{(\Sigma z_2)^2}{4} + \frac{(\Sigma z_3)^2}{4} + \frac{(\Sigma z_4)^2}{4} - C.F.$$

$$= \frac{-2^2}{4} + \frac{-24^2}{4} + \frac{13^2}{4} + \frac{20^2}{4} - C.F.$$

$$= 287.25 - 3.0625 = 284.1875$$

step 6 : To find SSE

$$SSE = TSS - SSC - SSR - SST$$

$$= 329.94 - 4.6875 - 6.6875 - 284.1875$$

$$= 34.375$$

Step 7: Annova table.

Source of variations	Sum of Squares	Degrees of Freedom	Mean Sum of Squares	F-Ratio
Column	SSC: 4.6875	$c-1 = 3$	$MSC = \frac{4.6875}{3} = 1.5625$	$F_c : \frac{5.7291}{1.5625} = 3.6666$ $F_\alpha(6,3) = 9$
Row	SSR: 6.6875	$r-1 = 3$	$MSR : \frac{6.6875}{3} = 2.2291$	$F_R : \frac{5.7291}{2.2291} = 2.5701$ $F_\alpha(6,3) = 9$
Treatment	SST: 284.1875	$T-1 = 3$	$MST : \frac{284.1875}{3} = 94.7291$	$F_T : \frac{94.7}{5.72}$ $\times 16.53$ $F_\alpha(3,6) : 4.7$
Error.	SSE: 34.375	$(n-1)(n-2)$ $3 \times 2 = 6$	$MSE : \frac{34.375}{6} = 5.7291$	

Step 8: Conclusion:

$F_c = 3.6666 < 9.94 = F_\alpha$, H_0 is accepted

$F_R = 2.5701 < 9.94 = F_\alpha$, H_0 is accepted

$F_T = 16.5347 > 4.76 = F_\alpha$, H_0 is rejected

(a) There is difference between the fertilizers.

2) Analyse the variance in the Latin square of yields (in quintals) of wheat where P, Q, R, S represent the different manures used.

S 222	P 221	R 223	Q 222
Q 224	R 223	P 222	S 225
P 220	Q 219	S 220	R 221
R 222	S 223	Q 221	P 222

Test whether the different manures used have given significantly different yields.

Soln: $F_C : 1.34$; $F_R : 12.31$, $F_T : 2.12$ & $F_\alpha : 4.76$.