



DEPARTMENT OF MATHEMATICS

UNIT - II DESIGN OF EXPERIMENTS

RANDOMISED BLOCK DESIGN (RBD) (ii) TWO WAY CLASSIFICATION

1) The yield of four strains of a particular variety of wheat was planted in five randomized blocks in kgs per plots is given below.

		Blocks				
		1	2	3	4	5
strains	A	32	24	34	35	36
	B	33	33	36	37	34
	C	30	35	35	32	35
	D	29	22	30	28	28

Test for difference between blocks and difference between strains.

Origin: $x_{ij} - 30$

Strains	Blocks →									
↓	A	B	C	D						
	1	2	3	4	5					
	2	4	4	5	6					
	3	3	6	7	4					
	0	5	5	2	5					
	-1	-8	0	-2	-2					
x_1	x_2	x_3	x_4	x_5	total	x_1^2	x_2^2	x_3^2	x_4^2	x_5^2
2	4	4	5	6	21	4	16	16	25	36
3	3	6	7	4	23	9	9	36	49	16
0	5	5	2	5	17	0	25	25	4	25
-1	-8	0	-2	-2	-13	1	64	0	4	4
<u>4</u>	<u>4</u>	<u>15</u>	<u>12</u>	<u>13</u>	<u>48</u>	<u>14</u>	<u>114</u>	<u>77</u>	<u>82</u>	<u>81</u>
Σx_1	Σx_2	Σx_3	Σx_4	Σx_5		Σx_1^2	Σx_2^2	Σx_3^2	Σx_4^2	Σx_5^2



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Step 1: Formulating H_0 and H_1 :

H_0 : There is no significant diff between blocks and strains.

H_1 : There is significant diff between blocks and strains.

Step 2: To find T & N:

$$T = \sum n_1 + \sum n_2 + \sum n_3 + \sum n_4 + \sum n_5 \\ = 4 + 4 + 15 + 12 + 13 = 48$$

$$N = n_1 + n_2 + n_3 + n_4 + n_5 \\ = 4 + 4 + 4 + 4 + 4 = 20$$

Step 3: Correction factor, C.F.

$$C.F. = \frac{T^2}{N} = \frac{48^2}{20} = 115.2$$

Step 4: $TSS = \sum n_1^2 + \sum n_2^2 + \sum n_3^2 + \sum n_4^2 + \sum n_5^2 - C.F.$

$$= 14 + 114 + 77 + 82 + 81 - 115.2 \\ = 252.8$$

Step 5: $SSC = \frac{(\sum n_1)^2}{n_1} + \frac{(\sum n_2)^2}{n_2} + \frac{(\sum n_3)^2}{n_3} + \frac{(\sum n_4)^2}{n_4} + \frac{(\sum n_5)^2}{n_5} - C.F.$

$$= \frac{4^2}{4} + \frac{4^2}{4} + \frac{15^2}{4} + \frac{12^2}{4} + \frac{13^2}{4} - 115.2 \\ = 27.3$$

$$SSR = \frac{(\sum y_1)^2}{n_1'} + \frac{(\sum y_2)^2}{n_2'} + \frac{(\sum y_3)^2}{n_3'} + \frac{(\sum y_4)^2}{n_4'} + \frac{(\sum y_5)^2}{n_5'} - C.F.$$
$$= \frac{21^2}{5} + \frac{23^2}{5} + \frac{17^2}{5} + \frac{13^2}{5} - 115.2 \\ = 170.4$$



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Step 6: $SSE = TSS - SSC - SSR$
 $= 252.8 - 27.3 - 170.4$
 $= 55.1$

Step 7: Anova table.

Source of Variations	Sum of squares	Degrees of freedom	Mean sum of square	F-Ratio
Column	SSC: 27.3	$c-1 = 5-1 = 4$	MSE: $\frac{27.3}{4} = 6.825$	$F_c = \frac{6.825}{4.59} = 1.486$ $F_{\alpha}(4, 12) = 3.26$
Row	SSR: 170.4	$r-1 = 4-1 = 3$	MSR: $\frac{170.4}{3} = 56.8$	$F_r = \frac{56.8}{4.59} = 12.37$ $F_{\alpha}(3, 12) = 3.49$
ERROR	SSE: 55.1	$(r-1) \times (c-1) = 4 \times 3 = 12$	MSE: $\frac{55.1}{12} = 4.59$	

Step 8: Conclusion:

$F_c < F_{\alpha}$ H_0 is accepted.

$F_r < F_{\alpha}$, H_0 is accepted.

\therefore , There is no significance diff between stocks and steams.



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3) A Tea Company appoints four salesmen A, B, C and D and observes their sales in three seasons, summer, winter and monsoon. The figures (in lakhs) are given in the following table.

Seasons	Salesman				Seasons Total
	A	B	C	D	
Summer	36	36	21	35	128
Winter	28	29	31	32	120
Monsoon	26	28	29	29	112
Salesman's total	90	93	81	96	360

- i) Do the salesmen significantly differ in performance?
- ii) Is there significant difference between the seasons?