

# UNIVERSITY OF KARACHI



## Probability and Statistical Methods

BSCS-306

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## Assignment : 12

### ANALYSIS OF VARIANCE (ANOVA)

#### QUESTION : 01

	A	B	C	D	E	
	30.5	48.3	79.2	60.6	79.0	
	32.5	42.1	84.7	59.4	85.3	
	27.2	43.5	85.0	57.3	86.2	
	26.3	40.6	88.2	59.0	87.2	
	25.1	38.6	76.3	58.7	81.7	
	38.2	32.1	83.1	68.1	93.5	
	30.6	41.6	92.6	64.8	89.1	
	33.7	38.8	88.5	55.5		
Total	244	325.6	677.6	474.4	684	

	A	B	C	D	E	Total
Sum (y)	244	325.6	677.6	474.4	684	2405.6
mean (y)	30.5	40.7	84.7	59.3	85.5	60.14

$$H_0 : \mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$$

$H_A$  : at least two means are not equal.

$$\alpha = 0.05$$

$$n = 8, k = 5, N = 40.$$



$$S.S.T_x = n \sum_{i=1}^k (\bar{y}_i - \bar{y})^2$$

$$S.S.T_x = 8(2503.473)$$

$$S.S.T_x = 20027.776$$

$$S.S.T = \sum_{i=1}^n \sum_{j=1}^k (y_{ij} - \bar{y})^2$$

$$S.S.T = 20836.74$$

$$S.S.E = S.S.T - S.S.T_x$$

$$= 20836.74 - 20027.776$$

$$S.S.E = 808.94$$

$$M.S.T_x = \frac{S.S.T_x}{k-1} = \frac{20027.776}{4}$$

$$M.S.T_x = 5006.94$$

$$M.S.E = \frac{S.S.E}{N-k} = \frac{808.964}{40-4}$$

$$M.S.E = 23.113$$



$$F_{cal} = \frac{MSTr}{MSE} = \frac{5006.944}{23.114}$$

$$F_{cal} = 216.62$$

$$F_{tab} = F(0.05, 4, 35)$$

$$F_{tab} = 2.69$$

Since  $F_{cal} > F_{tab}$ , we reject the  $H_0$  in favour of  $H_A$ .

QUESTION 2 02

Stones	I	II	III	Total
Sum(y)	74.95	113.32	150.87	339.14
Mean( $\bar{y}$ )	12.49	12.59	12.57	12.55

$$K=3, n_1=6, n_2=9, n_3=12, N=27$$

$$\alpha = 0.05$$

$$H_0: \mu_1 = \mu_2 = \mu_3$$

$H_A$ : At least two means are different.



$$S.S.T = 13.5009$$

$$S.S.T_v = 6(12.49 - 12.55)^2 + 9(12.59 - 12.55)^2 + 12(12.57 - 12.55)^2$$

$$S.S.T_v = 0.0408$$

$$S.S.E = S.S.T - S.S.T_v$$

$$S.S.E = 13.46$$

$$M_{gTv} = \frac{S.S.T_v}{K-1} = \frac{0.0408}{2} = 0.0204$$

$$MSE = \frac{SSE}{N-K} = \frac{13.46}{27-3} = 0.56$$

$$F_{cal} = \frac{0.0204}{0.56} = 0.036$$

$$F_{tab} = F_{(0.05, 2, 24)} = 3.40$$

Since  $F_{tab} > F_{cal}$  we fail to reject  $H_0$ .



## QUESTION 2 03

Mixing Techniques	1	2	3	4	Total
Tenile strength $\sum(y)$	1184	12625	11735	10665	46909
Mean $(\bar{y})$	2961	3156.25	2933.75	2666.25	2931.81

$$H_0 : \mu_1 = \mu_2 = \mu_3 = \mu_4$$

$$H_A : \text{At least two means are different}$$

$$K = 4, n = 4, N = 16, \alpha = 0.05$$

$$SST = \sum_{i=1}^n \sum_{j=1}^K (y_{ij} - \bar{y})^2$$

$$SST = 643648.34$$

$$SSTr = n \sum_{i=1}^n (\bar{y}_i - \bar{y})^2$$

$$= 4 (122435.0469)$$

$$SSTr = 489740.1876$$

$$SSE = SST - SSTr$$

$$= 643648.34 - 489740.18$$

$$SSE = 153908.16$$



$$MSTr = \frac{S.S.Tr}{K-1} = 163246.72$$

$$MSE = \frac{SSE}{N-K} = 12825.68$$

$$F_{cal} = \frac{MSTr}{MSE} = 12.72$$

$$F_{tab} = F(0.05, 3, 12) = 3.49$$

Since  $F_{cal} > F_{tab}$  we reject  $H_0$  in favour of  $H_A$ .

Question Q5.

Group (y)	$T_1$	$T_2$	$T_3$	$T_4$	$T_5$	Total
Before (y)	59.86	58.59	62.6	60.31	59.49	60.89
Sum (y)	218.32	585.99	498.11	844.38	342.06	3532.86

$$S.S.P = 157.3245$$



$$S \cdot ST_r = 12(59.86 - 60.09)^2 + 10(58.59 - 60.09)^2 + \\ 8(62.26 - 60.09)^2 + 14(60.31 - 60.09)^2 + \\ 15(59.47 - 60.09)^2$$

$$SST_r = 67.24$$

$$S \cdot SE = S \cdot ST - S \cdot ST_r \\ = 157.38 - 67.24 = 90.14$$

$$M \cdot ST_r = \frac{S \cdot ST_r}{k-1} = 16.81$$

$$M \cdot SE = \frac{SSE}{N-K} = 1.66$$

$$F_{cal} = \frac{MST_r}{MSE} = 10.12$$

$$f_{tab} = F(0.05, 4, 47) = 2.61$$