QUESTIONS

1. The average number of days survived by mice inoculated with 5 strains of typhoid organisms along with their standard deviation and number of mice involved in each experiment is given below. On the basis of these data, what would be your conclusions regarding the strains of typhoid organisms ?

Strains of typhoid	A	B	C	D	E
No. of mice, n_i	10	6	8	11	5
Average, $\overline{y_i}$	10.9	13.5	11.5	11.2	15.4
Standard deviation, s_i	12.72	5.96	3.24	5.65	3.64

2. (a) A manufacturing company has purchased three new machines of different makes and wishes to determine whether one of them is faster than the others in producing a certain output. Five-hourly production figures are observed at random from each machine and the results are as follows.

	Machine A_1	Machine A_2	Machine A_3
Observations	25	31	24
	30	39	30
	36	38	28
	38	42	25
	31	35	28

Use analysis of variance technique and determine whether the machines are signifacntly different in their mean speeds. Use $\alpha = 5\%$.

(b) Analyse the above data after shifting the origin to 30. How are the results in Part (a) affected ? Explain.

3. The following table gives quality rating of ten service stations by five professional raters.

RATER	SERVICE STATION									
	1	2	3	4	5	6	7	8	9	10
A	99	70	90	99	65	85	75	70	85	92
B	96	65	80	95	70	88	70	51	84	91
C	95	60	48	87	48	75	71	93	80	93
D	98	65	70	95	67	82	73	94	86	80
E	97	65	62	99	60	80	76	92	90	89

Analyse the data and discuss whether there is any significant difference between raters or between service stations.

4. The following data shows the birth-weights of babies born, classified according to the age of mother and order of gravida, there being three observations per cell :

Order of gravida	Age-group of mother				
	15-20	20-25	25-30	30-35	35 and over
1	5.1, 5.0, 4.8	5.0, 5.1, 5.3	5.1, 5.1, 4.9	4.9, 4.9, 5.0	5.0, 5.0, 5.0
2	5.2, 5.2, 5.4	5.3, 5.3, 5.5	5.3, 5.2, 5.2	5.2, 5.0, 5.5	5.1, 5.3, 5.0
3	5.8, 5.7, 5.9	6.0, 5.9, 6.2	5.8, 5.9, 5.9	5.8, 5.5, 5.5	5.9, 5.4, 5.5
4	6.0, 6.0, 5.9	6.2, 6.5, 6.0	6.0, 6.1, 6.0	6.0, 5.8, 5.5	5.8, 5.6, 5.5
5 and over	6.0, 6.0, 6.0	6.0, 6.1, 6.3	5.9, 6.0, 5.8	5.9, 6.0, 5.5	5.5, 6.0, 6.2

Test whether the age of mother and order of gravida significantly affect the birth-weight.

5. An experiment was conducted to determine the effects of different dates of planting and different methods of planting on the yield of sugar-cane. The data below show the yields of sugar-cane (in kg.) for four different dates and three methods of planting.

Method of Planting	Date of planting			
	October	November	February	March
I	7.10	3.69	4.70	1.90
II	10.29	4.79	4.58	2.64
III	8.30	3.58	4.90	1.80

Carry out an analysis of the above data.

6. The following table provides marks obtained by 20 undergraduate students in Statistics Honours in a college test and in the subsequent University examination. Fit a simple linear regression model to the data.

Serial No.	Marks Obtained	
	in college test	in university examination
1	183	433
2	175	393
3	134	270
4	170	364
5	183	399
6	167	360
7	120	368
8	175	358
9	126	262
10	187	376
11	123	326
12	121	341
13	175	403
14	133	326
15	144	346
16	109	255
17	165	362
18	114	361
19	164	382
20	125	319

7. For 20 pairs of fathers and sons, the regression equation of height of son (y) on height of father (x), both measured in $c.m.$, was found to be

$$y = 9.29 + 0.932x.$$

Test whether a differs significantly from zero and b differs significantly from unity. For the 20 pairs, $\overline{x} = 168.17$, $\sum_{i=1}^{20} (x_i - \overline{x})^2 = 777.80$ and $\sum_{i=1}^{20} (y_i - \overline{y})^2 = 939.42$.

8. The following table shows, for each of 18 cinchona plants, the yield of dry bark (in oz.), the height (in inches) and the girth (in inches) at a height of 6″ from the ground. Fit a multiple linear regression model to the data.

Plant no.	Yield of dry bark (oz.)	Height (in.)	Girth at a height of 6″
1	19	8	4
2	51	15	5
3	30	11	3
4	42	21	3
5	25	7	2
6	18	5	1
7	44	10	4
8	56	13	6
9	38	12	3
10	32	13	4
11	25	5	2
12	10	6	3
13	20	4	4
14	27	8	4
15	13	7	3
16	49	12	5
17	27	6	3
18	55	16	7

9. During a crop-cutting survey, a random sample of 16 equal-sized small plots was taken and the green weight (x) and dry weight (y) in kg. of paddy were recorded for each plot. Given that,

$$\sum_{i=1}^{16} x_i = 203.6, \qquad \sum_{i=1}^{16} y_i = 186.6, \qquad \sum_{i=1}^{16} x_i^2 = 2801.88,$$

$$\sum_{i=1}^{16} y_i^2 = 2255.56, \qquad \sum_{i=1}^{16} x_i y_i = 2458.84;$$

obtain the linear regression equation of y on x. Hence test whether the regression coefficient differs significantly from zero.

10. Students in a statistics class (taught by one of the authors) claimed that doing the homework had not helped to prepare them for the midterm exam. The exam score y and homework score x (averaged upto the time of midterm) for the 18 students in the class were as follows :

y	x	y	x
95	96	90	93
80	77	0	18
0	0	95	86
0	0	35	0
79	78	50	30
77	64	72	59
72	89	55	77
66	47	75	74
98	90	66	67

Based on this data, verify the students' claim.

11. The following table gives the birth weights of 8 litters of pigs, the litters being of different sizes. Analyse the data to find if the litter means are different and also determine whether the size of litter is an assignable cause of variation.

Litters	1	2	3	4	5	6	7	8
Birth weights	2.0	3.5	3.3	3.2	2.6	3.1	2.6	2.5
	2.8	2.8	3.6	3.3	2.6	2.9	2.2	2.4
	3.3	3.2	2.6	3.2	2.9	3.1	2.2	3.0
	3.2	3.5	3.1	2.9	2.0	2.5	2.5	1.0
	4.4	2.3	3.2	3.3	2.0		1.2	
	3.6	2.4	3.3	2.5	2.1		1.2	
	1.9	2.0	2.9	2.6				
	3.3	1.6	3.4	2.8				
	2.8		3.2					
	1.1		3.2					

12. Consider the following data :

x_1	x_2	y
17	42	90
19	45	71, 76
20	29	63, 63, 80, 80
21	93	80, 64, 82, 66
25	34	75, 82
27	98	99
28	99	73
30	73	67, 74

Fit the model $y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \epsilon$.

13. The following experiment was suggested to test whether subjecting seeds to high temperature and low temperature before planting has any effect on yield. Ten plots were taken and in each 6 seeds were sown at random. Two of the seeds were subjected to high temperatuer (h.t.), two to low temperature (l.t.) and two were subject to controls. The yield of individual plants in gms. are recorded in the following table. Test for the comparison of yields under the two treatments and control.

Plot No.	h.t.		l.t.		Control	
	Plant I	Plant II	Plant I	Plant II	Plant I	Plant II
1	15	16	20	22	25	24
2	20	15	30	29	40	35
3	16	14	18	16	20	18
4	18	15	20	22	22	26
5	21	22	20	19	30	28
6	10	8	16	14	16	15
7	14	12	17	10	16	20
8	15	11	20	18	19	17
9	16	15	14	15	25	22
10	17	14	15	14	14	18

14. The cost of maintenance of shipping tractors seems to increase with the age of the tractor.

    (a) Fit the model $Y = \beta_0 + \beta_1 X + \epsilon$.

    (b) Is the model suitable ?

Age (Years) x	6 month's cost y
4.5	619
4.5	1049
4.5	1033
4.0	495
4.0	729
4.0	681
5.0	890
5.0	1522
5.5	987
5.0	1194
0.5	163
0.5	182
6.0	764
6.0	1373
1.0	978
1.0	466
1.0	549

15. In an experiment on cotton with 5 manurial treatments, it was observed that the number of plants per plot is varying from plot to plot. The yields of cotton (Kapas) along with the number of plants per plot are given in the following table. Analyse the yield data removing the effect of the variation in plant population on the yield by analysis of covariance technique and draw your conclusions. The design adopted was a $R.B.D$ with 4 replications.

Treatments : 5 levels of Nitrogen :

$N_0 = 0$, $N_1 = 20$, $N_2 = 40$, $N_3 = 60$ and $N_4 = 80$ kg/ha.

Replicate I	N_1 12.0 (24)	N_0 10.5 (30)	N_4 27.0 (30)	N_2 16.5 (28)	N_3 25.0 (35)
Replicate II	N_3 26.0 (40)	N_2 20.0 (25)	N_0 12.0 (25)	N_4 26.0(22)	N_1 15.5 (28)
Replicate III	N_2 22.0 (32)	N_4 30.0 (35)	N_3 20.0 (24)	N_1 20.0 (35)	N_0 14.5 (30)
Replicate IV	N_1 19.0 (26)	N_3 18.5 (16)	N_0 8.5 (24)	N_4 29.0 (30)	N_2 25.0 (35)

16. In the following table are initial weights X (pounds), average daily gains Y (pounds per day) of four lots of swine fed with different rations.

Assuming that the data on initial weights are not available, examine whether the four rations differ in inducing gain in weight.

	Lot 1		Lot 2		Lot 3		Lot 4	
Ration	X	Y	X	Y	X	Y	X	Y
1	62	1.2	79	2.0	71	1.2	61	1.4
2	73	1.4	65	1.8	60	1.3	59	1.8
3	58	1.3	57	1.6	54	1.4	59	1.6
4	43	1.3	51	1.8	50	1.4	53	1.5
5	50	1.4	57	1.9	60	1.2	56	1.7
6	44	1.2	66	1.5	61	1.2	50	1.5
7	88	1.0	44	1.6	44	1.2	50	1.4
8	51	1.6	41	1.5	53	1.0	39	1.4
9	40	1.2	44	1.8	41	1.1	38	1.3
10	38	1.1	36	1.3	38	1.1	45	1.3