QUESTIONS

1. A set of data involving four "tropical feed stuffs A, B, C, D" tried on 20 chicks is given below. All the twenty chicks are treated alike in all respects except the feeding treatments and each feeding treatment is given to 5 chicks. Analyse the data.

Feed	Gain in Weight					Total T_i
A	55	49	42	21	52	219
B	61	112	30	89	63	355
C	42	97	81	95	92	407
D	169	137	169	85	154	714

2. Consider the results given in the following table for an experiment involving six treatments in four randomised blocks. The treatments are indicated by numbers within parentheses.

Blocks	Yield for a randomised block experiment					
1	(1)	(3)	(2)	(4)	(5)	(6)
	24.7	27.7	20.6	16.2	16.2	24.9
2	(3)	(2)	(1)	(4)	(6)	(5)
	22.7	28.8	27.3	15.0	22.5	17.0
3	(6)	(4)	(1)	(3)	(2)	(5)
	26.3	19.6	38.5	36.8	39.5	15.4
4	(5)	(2)	(1)	(4)	(3)	(6)
	17.7	31.0	28.5	14.1	34.9	22.6

Test whether the treatments differ significantly. Also

(i) determine the critical difference between the means of any two treatments;

(ii) obtain the efficiency of this design relative to its layout as $C.R.D.$

3. An experiment was carried out to determine the effect of claying the ground on the field of barley grains; amount of clay used were as follows :
   A : No clay
   B : Clay at 100 per acre
   C : Clay at 200 per acre
   D : Clay at 300 per acre.
   The yields were in plots of 8 meters by 8 meters and are given in the following table.

	I	II	III	IV
I	D 29.1	B 18.9	C 29.4	A 5.7
II	C 16.4	A 10.2	D 21.2	B 19.1
III	A 5.4	D 38.8	B 24.0	C 37.0
IV	B 24.9	C 41.7	A 9.5	D 28.9

   (i) Perform the ANOVA and calculate the critical difference for the treatment mean yields.

   (ii) Calculate the efficiency of the above Latin Square Design over
      (a) $R.B.D.$
      (b) $C.R.D.$

   (iii) Yield under 'A' in the first column was missing. Estimate the missing value and carry out the ANOVA.

4. A varietal trial was conducted at a Research Station. The design adopted for the same was five randomised blocks of 6 plots each. The yields in lb. per plot (of $\frac{1}{20}$th of an acre) obtained from the experiment are given in the following table.

Blocks	Varieties					
	V_1	V_2	V_3	V_4	V_5	V_6
I	30	23	34	25	20	13
II	39	22	28	25	28	32
III	56	43	43	31	49	17
IV	38	45	36	35	32	20
V	44	51	23	58	40	30

   Analyse the design and comment on your findings.

5. The following data were obtained from an experiment using the treatments : 0.32 % of Blitox, 0.16 % of Dithane z-78, 0.09 % of Brestan-60 and control. After sowing rhizomes of the matgrass *Cyperus tagetum Roxb* in four plots in each of three villages, the above four treatments were applied at random to the plots in each village after 30 days of sowing. The yields in gm. of 30 sq. cm. cutting per plot after 120 days are given below. Analyse the data to find out if there are any significant treatment effects.

Treatment	Village		
	I	II	III
Blitox	678.2	510.2	531.2
Dithane z-78	703.2	689.5	611.2
Brestan-60	736.8	574.2	573.7
Control	556.4	510.2	500.0

6. Analyse the following randomised block design after estimating the missing value. Also compare the treatments T_1 and T_2.

Treatment	Blocks			
	I	II	III	IV
T_1	19.1	–	22.5	25.5
T_2	26.0	28.0	27.0	33.0
T_3	20.5	28.5	21.5	25.5

7. The following table gives the yield of wheat (kgs./plot) as observed in an experiment carried out in a 5×5 Latin Square. The five manurial treatments are indicated by A, B, C, D and E. Obtain an estimate of the missing value and analyse the design.

	1	2	3	4	5
1	B 57.8	C 48.6	A 33.4	D 53.5	E 41.8
2	D 50.5	E 45.5	C 51.8	B 52.6	A 31.9
3	A 46.1	D 47.9	B 55.6	E –	C 53.3
4	C 58.2	B 55.1	E 43.2	A 38.8	D 53.3
5	E 53.0	A 41.0	D 48.7	C 54.6	B 55.7

8. Consider the following 2^2 factorial experiment involving 2 factors N and S each at two levels - 0 and 1.

Block	Treatment Combination			
	(1)	n	s	ns
I	117	124	106	125
II	120	124	117	124
III	111	127	114	126
IV	108	131	112	125
V	73	138	97	95
VI	81	158	117	125

Analyse the design. Does treatment effect N differ from treatment effect S significantly ?

9. Analyse the following 2^3 factorial experiment in blocks of 4 plots, involving three fertilisers N, P and K each at two levels.

Replicate I

Block 1	np	npk	(1)	k
	101	111	75	55
Block 2	p	n	pk	nk
	88	90	115	75

Replicate II

Block 3	(1)	npk	nk	p
	125	95	80	100
Block 4	np	k	pk	n
	115	95	90	80

Replicate III

Block 5	pk	nk	(1)	np
	75	100	55	92
Block 6	n	npk	p	k
	53	76	65	82

10. An experiment was performed by Gretchen Krueger at Arizona State University to determine how the pan material, the brand of brownie mix and the stirring method affect the scrumptiousness of brownies.

    The factor levels were:

Factor	Low (−)	High (+)
A = pan material	Glass	Aluminium
B = stirring method	Spoon	Mixer
C = brand of mix	Expensive	Cheap

    The response variable was scrumptiousness, a subjective measure derived from a questionnaire given to the subjects who tasted each batch of brownies. The test panel results for eight persons corresponding to each batch are given below.

Brownie Batch	Treatment Combination			Test Panel Result							
	A	B	C	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	−	−	−	11	9	10	10	11	10	8	9
2	+	−	−	15	10	16	14	12	9	6	15
3	−	+	−	9	12	11	11	11	11	11	12
4	+	+	−	16	17	15	12	13	13	11	11
5	−	−	+	10	11	15	8	6	8	9	14
6	+	−	+	12	13	14	13	9	13	14	9
7	−	+	+	10	12	13	10	7	7	17	13
8	+	+	+	15	12	15	13	12	12	9	14

    Analyse the data and comment on the results.

11. The yield data (in kg. per plant) obtained in a factorial experiment to compare the effect of three fertilizers N, P and K each at two levels applied on a variety are given below.

Replicate I

Block 1	npk	k	p	n
	12.0	17.7	14.6	12.7
Block 2	nk	np	pk	(1)
	11.7	12.8	13.8	10.9

Replicate II

Block 3	npk	p	k	n
	10.3	8.9	9.3	10.8
Block 4	np	nk	pk	(1)
	9.3	9.8	10.0	12.7

Replicate III

Block 5	nk	np	p	k
	12.3	10.3	15.2	14.3
Block 6	n	pk	(1)	npk
	11.3	13.0	10.7	11.5

Each replicate consists of two blocks of 4 plots each. Find the confounded effects, analyse the data and draw conclusion.

12. Analyse the following 2^3 completely confounded factorial design.

Replicate I

Block 1	(1)	nk	np	kp
	101	291	373	391
Block 2	nkp	n	k	p
	450	106	265	312

Replicate II

Block 3	(1)	nk	np	kp
	106	306	338	407
Block 4	nkp	n	k	p
	449	89	272	324

Replicate III

Block 5	(1)	nk	np	kp
	87	334	324	423
Block 6	nkp	n	k	p
	471	128	279	323

Replicate IV

Block 7	(1)	nk	np	kp
	131	272	361	445
Block 8	nkp	n	k	p
	437	103	302	324

(N = Nitrogen; K = Potash; P = Phosphate)

13. For a Factorial Experiment with 3 factors N, P, K each at two levels, the design and yield per plot are given below. Analyse the data.

Replicate I

Block 1	(1)	pk	nk	np
	25	24	32	30
Block 2	n	k	npk	p
	30	32	36	27

Replicate II

Block 3	p	npk	n	k
	32	42	46	39
Block 4	nk	(1)	np	pk
	34	44	30	36

Replicate III

Block 5	npk	k	n	p
	30	32	28	26
Block 6	(1)	pk	nk	np
	24	20	28	36

Replicate IV

Block 7	np	(1)	pk	nk
	32	34	39	41
Block 8	npk	n	p	k
	45	41	29	35

14. For a Factorial Experiment with 3 factors N, K, P each at two levels, the design and yield per plot are given below. Analyse the data.

Replicate I

Block 1	(1)	nk	np	kp
	99	201	312	376
Block 2	nkp	n	k	p
	408	98	260	306

Replicate II

Block 3	(1)	nk	np	kp
	100	308	352	412
Block 4	nkp	n	k	p
	452	87	257	378

Replicate III

Block 5	(1)	nk	np	kp
	84	378	324	435
Block 6	nkp	n	k	p
	456	135	272	378

Replicate IV

Block 7	(1)	nk	np	kp
	152	296	372	278
Block 8	nkp	n	k	p
	478	178	319	372

15. A variety-manurial experiment was conducted by alloting the three varieties V_1, V_2 and V_3 at random to the plots of four randomised blocks and then, splitting each plot into four sub-plots, the four manures M_1, M_2, M_3, M_4 where applied at random within each plot. The plan and yields are shown below. Analyse the data to find out if there are any effects due to manure or variety or interaction between variety and manure.

Block I

V_1		V_2		V_3	
M_1	94	M_4	440	M_2	250
M_3	220	M_2	297	M_1	147
M_2	185	M_3	218	M_3	248
M_4	110	M_1	112	M_4	275

Block II

V_2		V_1		V_3	
M_1	135	M_2	160	M_4	370
M_4	290	M_4	95	M_1	140
M_2	180	M_3	124	M_3	340
M_3	265	M_1	71	M_2	222

Block III

V_1		V_2		V_3	
M_1	78	M_3	196	M_2	235
M_3	135	M_4	262	M_3	260
M_4	130	M_1	155	M_1	115
M_2	145	M_2	220	M_4	483

Block IV

V_1		V_3		V_2	
M_1	81	M_2	246	M_3	296
M_2	175	M_3	191	M_2	250
M_4	175	M_1	145	M_1	122
M_3	114	M_4	323	M_4	450

16. The field plan and yield of a strip-plot experiment with 3 dates of planting (d_1, d_2, d_3) and 3 methods of ploughing (m_1, m_2, m_3) in 4 replicates are given below. Analyse the data to find out if there are any effects due to dates or methods or interaction between date and method.

Replicate I

	m_2	m_1	m_3
d_1	290	71	220
d_3	370	140	218
d_2	95	135	248

Replicate II

	m_1	m_3	m_2
d_3	185	297	248
d_1	222	124	135
d_2	180	160	140

Replicate III

	m_2	m_3	m_1
d_3	175	246	296
d_2	145	175	112
d_1	81	191	250

Replicate IV

	m_2	m_1	m_3
d_2	135	78	235
d_1	196	155	220
d_3	260	115	145