

DESIGN OF EXPERIMENTS

1. A set of data involving four '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 weight gain of baby chicks fed on different feeding materials composed of tropical feed stuffs:

					Total
A	55	49	42	21	52
B	61	112	30	89	63
C	42	97	81	95	92
D	169	137	169	85	154
		Grand Total			G= 1695

2. An experiment was planned to study the effect of sulphate of potash and super phosphate and 2 levels of super phosphate and 2 levels of sulphate of potash were studied in a randomized block design with 4 replication for each. The yields (per plot) obtained are given below.

Block	Yields (lbs per plot)		
I	(I)	k	p
	23	25	22
II	p	(I)	k
	40	26	36
III	(I)	k	kp
	29	20	30
IV	kp	k	p
	34	31	24
			28

3. An experiment was designed to study the performance of 4 different detergents for cleaning fuel injectors. The following 'Cleanness' readings were obtained with specially designed equipment for 12 tanks of gas distributed over 3 different model of engineers.

	Engine I	Engine II	Engine III
Detergent A	45	43	51
Detergent B	47	46	52
Detergent C	48	50	55
Detergent D	42	37	49

Looking on the detergents of treatments and the engines at blocks, Obtain the appropriate analysis of variance table and test at the 0.01 level of significance whether there are differences in detergents or in engines.

4. A farmer wishes to test the effects of four different Fertilizers A, B, C, D on the yield of wheat. In order to eliminate sources of error due to variability in soil fertility, he uses the fertilizers in a Latin square arrangement as indicated in the following table, where the numbers indicate yields in bushels per unit area.

A18	C21	D25	B11
D22	B12	A15	C19
B15	A20	C23	D24
C22	D21	B10	A17

Perform an analysis of variance to determine if there is a significant difference between the Fertilizers at $\alpha=0.05$ levels of significance.

5. The following are the cholesterol contents, in milligrams per package, which four laboratories obtained for 6 ounce packages of three very similar diet foods:

	Diet food A	Diet food B	Diet food C
Laboratory 1	3.4	2.6	2.8
Laboratory 2	3.0	2.7	3.1
Laboratory 3	3.3	3.0	3.4
Laboratory 4	3.5	3.1	3.7

Perform a two-way analysis of variance and test the null hypothesis concerning the diet food and the laboratories at the 0.05 level of significance.

6. To examine the effects of three drugs on systolic blood pressure an experiment was arranged in a randomized block design. Four groups of three patients each were used. The following the table shows the changes in the blood pressure after administering the drugs.

Drugs	Groups			
	G ₁	G ₂	G ₃	G ₄
D ₁	4	0	4	2
D ₂	2	-3	6	0
D ₃	1	1	3	4

Test whether the drugs differ in their effects on blood pressure.

7. When three different lubricants were used in controlled condition:

Lubricant A: 12.2 11.8 13.1 11 3.9 4.1 10.3 8.4

Lubricant B: 10.9 5.7 13.5 9.4 11.4 15.7 10.8 14

Lubricant C: 12.7 19.9 13.6 11.7 18.3 14.3 22.8 20.4

Test at 0.05 level of significance, where the differences among the means of different lubricants differ significantly.

8. In a Latin square experiment given below, the yields is quintals per acre on the paddy crop carried out for testing the effect of five fertilizers A, B, C, D, E. Analysis the data for variations.

B25	A18	E27	D30	C27
A19	D31	C29	E26	B23
C28	B22	D33	A18	E27
E28	C26	A20	B25	D33
D32	E25	B23	C28	A20

9. Three machine A, B , C gave the production of pieces in four days as below. Is there a significant difference between machines?

A	17	16	14	13
B	15	12	19	18
C	20	8	11	17

10. A completely randomised design experiment with 10 plots and 3 treatments gave the following results:

Plot No	:	1	2	3	4	5	6	7	8	9	10
Treatment	:	A	B	C	A	C	C	A	B	A	B
Yield	:	5	4	3	7	5	1	3	4	1	7

Analyse the results for treatments effects.

11. The following table shows the lives in hours of four brands of electric lamps:

Brands	A	:	1610, 1610, 1650, 1680, 1700, 1720, 1800
	B	:	1580, 1640, 1640, 1700, 1750
	C	:	1460, 1550, 1600, 1620, 1640, 1660, 1740, 1820
	D	:	1510, 1520, 1530, 1570, 1600, 1680

Perform an analysis of variance and test the homogeneity of the mean lives of the four brands of lamps.

12. The three samples below have been obtained from normal population with equal variance. Test the hypothesis that the sample means are equal:

8	7	12
10	5	9
7	10	13
14	9	12
11	9	14

13. The following table gives the number of refrigerators sold by 4 salesman in three months:

Month	Salesman			
	A	B	C	D
I	50	40	48	39
II	46	48	50	45
III	39	44	40	39

Is there a significant difference in the sale made by the four salesmen?

Is there a significant difference in the sales made during different month?

14. The following data represent the number of units of production per day turned out by 5 different workers using 4 different types of machines:

	Machine type			
	A	B	C	D
1	44	38	47	36
2	46	40	52	43
3	34	36	44	32
4	43	38	46	33
5	38	42	49	39

(a).Test whether the five men differ with respect to mean productivity.

(b).Test whether the mean productivity is the same for the four different machine types.

15. Analyse the variance in the following Latin square of yields (in kgs) of paddy where A,B,C,D denote the different methods of cultivation

D 122	A 121	C 123	B 122
B 124	C 123	A 122	D 125
A 120	B 119	D 120	C 121
C 122	D 123	B 121	A 122

Examine whether the different methods of cultivation have given significantly different yields.

16. Four types of health drinks A, B, C, D were tried on the school children. In order to study the effects of the age groups of the children and localities, four schools from four different localities, were selected and students were divided into four age groups. The Latin square design was arranged. The gain in weights in same units is recorded below. Test whether the localities age groups and the varieties of food have any significant effect on the gain in weight.

5-8	Age groups				Total
	8-11	11-14	14-17		
A 2	B 1.8	C 2.1	D 1.5		7.4
D 1.3	A 1.4	B 1	C 1.2		4.9
B 1.7	C 1.6	D 1.1	A 1.9		6.3

17. Three varieties of a crop are tested in a randomized block design with four replications. The plot yield in pounds are as follows:

A6	C5	A8	B9
C8	A4	B6	C9
B7	B6	C10	A6

Analysis the experiment yields and states your conclusion.

18. A car rental agency, which uses 5 different brands of tyres in the process of deciding the brand of tyre to purchase as standard equipment for its fleet, finds that each of 5 tyres of each brands last the following number of kilometres (in thousands)

Tyre brands				
A	B	C	D	E
36	46	35	45	41
37	39	42	36	39
42	35	37	39	37
38	37	43	35	35
47	43	38	32	38

Test the hypothesis that the tyre brands have almost the same average life.

19. In order to determine whether there is significant difference in the durability of 3 makes of computers, sample of size 5 are selected from each make and the frequency of repair during the first year of purchase is observed. The results are as follows:

Makes		
A	B	C
5	8	7
6	10	3
8	11	5
9	12	4
7	4	1

In view of the above data, what conclusions can you draw?

20. Three varieties of a crop are tested in a randomised block design with four replications, the layout being as given below: The yields are given in kilograms. Analysis for significance

C 48	A 51	B 52	A 49
A 47	B 49	C 52	C 51
B 49	C 53	A 49	B 50

21. Five breeds of cattle B_1, B_2, B_3, B_4, B_5 were fed on four different rations R_1, R_2, R_3, R_4 . Gains in weight in kg over a given period were recorded and given below:

	B_1	B_2	B_3	B_4	B_5
R_1	1.9	2.2	2.9	1.8	2.1
R_2	2.5	1.9	2.3	2.6	2.2
R_3	1.7	1.9	2.2	2.0	2.1
R_4	2.1	1.8	2.5	2.3	2.4

If there is a significant difference between (i) breeds and (ii) rations?

22. Four doctors each test four treatments for a certain disease and observe the number of days each patient takes to recover. The results are as follows (recovery time in days)

Treatment				
Doctor	1	2	3	4
A	10	14	19	20
B	11	15	17	21
C	9	12	16	19
D	8	13	17	20

Discuss the difference between (a) doctors and (b) treatments.

23. The following data resulted from an experiment to compare three burners B₁, B₂ and B₃. A Latin square design was used as the tests were made on 3 engines and were spread over 3 days.

	Engine-1	Engine-2	Engine-3
Day-1	B ₁ -16	B ₂ -17	B ₃ -20
Day-2	B ₂ -16	B ₃ -21	B ₁ -15
Day-3	B ₃ -15	B ₁ -12	B ₂ -13

Test the hypothesis that there is no difference between the burners.

24. The following table gives the yields of wheat from 16 plots, all of approximately equal fertility, when 4 varieties of wheat were cultivated in a completely randomised fashion. Test the hypothesis that the varieties are not significantly different.

Plot No	:	1	2	3	4	5	6	7	8	9	10
Variety	:	A	B	D	C	B	C	A	D	B	D
Yield	:	32	34	29	31	33	34	34	26	36	39
Plot No	:	11	12	13	14	15	16				
Variety	:	A	C	B	A	B	C				
Yield	:	33	35	37	35	35	32				

25. A random sample is selected from each of 3 makes of ropes and their breaking strength (in certain units) are measured with the following results:

I	:	70	72	75	80	83	
II	:	60	65	57	84	87	73
III	:	100	110	108	112	113	120

Test whether the breaking strengths of the ropes differ significantly.

26. The weights in gm of a number of copper wires, each of length 1 metre, were obtained. These are shown classified according to the dye from which they come:

	D_1	D_2	D_3	D_4	D_5	D_6
:	1.30	1.32	1.36	1.35	1.32	1.37
:	1.28	1.35	1.33	1.34		
:	1.32	1.29	1.31	1.28	1.33	1.30
:	1.31	1.29	1.33	1.31	1.32	
:	1.30	1.32	1.30	1.33		

Test the hypothesis that there is no difference between the mean weights of wires coming from different dyes.

27. It is suspected that four machines used in a canning operation fills cans to different levels on the average. Random samples of can produced by each machine were taken and the fill (in ounces) was measured. The results are tabulated below:

Machine

A	B	C	D
10.20	10.22	10.17	10.15
10.18	10.27	10.22	10.27
10.36	10.26	10.34	10.28
10.21	10.25	10.27	10.40
10.25	-	-	10.30

Do the machines appear to be filling the cans at different average levels?

28. There are 3 typists working in an office. the times (in-minutes) they spend for tea-break in addition to the allowed lunch tea break are observed and noted below:

A	25	18	30	32	35	37	19		
B	24	22	26	28	30	32	28	26	
C	28	20	27	19	29	35	30	23	27

Can the difference in average times that the 3 typists spend for tea break be attributed to chance variation?

29. Different numbers of leaves were taken from each of 6 trees and their lengths measured. The following are the lengths in millimetres.

Tree	Lengths							
1	82	87	86	90	81	84		
2	85	84	91	92	88			
3	92	90	84	86	88	93	89	90
4	80	86	87	81	82	82		
5	87	86	88	90	85	86	87	
6	90	86	84	85	85	86	87	84
								87

Can all these leaves be regarded as having come from the same species of trees?

30. Four machines A,B,C,D are used to produce a certain kind of cotton fabric. 4 samples with each of size 100 square metres are selected from the outputs of the machines at random and number of flaws in each 100 square metres are counted, with the following results:

A	B	C	D
8	6	14	20
9	8	12	22
11	10	18	25
12	4	9	23

Do you think that there is a significant difference in the performance of the four machines?

31. The following table shows the yield (in certain units) of lima beans on 20 plots of land subject to 4 different treatments, 5 plots per treatment. Set up an analysis of variance table to test the significance of the differences between the yields due to different treatments.

T ₁ :	26.3	30.0	54.2	25.7	52.4
T ₂ :	18.5	21.1	29.3	17.2	12.4
T ₃ :	36.9	21.8	24.0	18.5	10.2
T ₄ :	39.8	28.7	21.2	39.4	29.0

32. To test the significance of the variation of the retail prices of a certain commodity in the 4 principal cities Mumbai, Kolkata, Delhi and Chennai, 7 Shops were chosen at random in each city and the prices (in Rs.) observed were as follows:

Mumbai :	100	97	91	87	87	81	79
Kolkata :	102	100	98	97	94	86	80
Delhi :	106	102	98	86	86	84	84
Chennai :	97	95	94	92	90	86	82

Do the data indicate that the prices in the 4 cities are significantly different?

33. Steel wire was made by 4 manufacturers A, B, C and D. In order to compare their products, 10 sample were randomly drawn from a batch of wires made by each manufacturer and the strength of each piece of wire was measured. The (coded) values are given below

A:	55	50	80	60	70	75	40	45	80	70
B:	70	80	85	105	65	100	90	95	100	70
C:	70	60	65	75	90	40	95	70	65	75
D:	90	115	80	70	95	100	105	90	100	60

Carry out an analysis of variance and give your conclusions.

34. A randomised block experiment was laid out (with 4 blocks, each block containing 4 plots) to test 4 varieties of manure A,B,C,D and the yields per acre are given as below. Test for the significance of the difference among the 4 varieties of manure.

Block I	A155	B152	C157	D156
Block II	B152	C150	D156	A154
Block III	C156	D153	A161	B162
Block IV	D153	A154	B156	C155

35. The following table gives the gains in weights of 4 different types of pigs fed on 3 different rations over a period. Test whether

- (i) the difference in the rations significant
- (ii) the 4 types of pigs differ significantly in gaining weight

Ration	Types of pig			
	I	II	III	IV
A	13.8	15.7	16.0	20.2
B	8.7	11.8	9.0	12.9
C	12.0	16.5	13.3	12.5

36. Four experiments determine the moisture content of samples of a powder, each observer taking a sample from each of six consignments. The assessments are given below:

Observer	Consignment					
	1	2	3	4	5	6
1	9	10	9	10	11	11
2	12	11	9	11	10	10
3	11	10	10	12	11	10
4	12	13	11	14	12	10

Perform an analysis of variance on these data and discuss whether there is any significant difference between consignments or between observers.

37. In order to compare three burners B_1 , B_2 and B_3 , one observation is made on each burner on each of four successive days. The data are tabulated below.

B_1	B_2	B_3
Day	21	23
Day	18	17
Day	18	21
Day	17	20

Perform an analysis of variance on these data and find whether the difference between (i) the days and (ii) the burners significant at 5% LOS

38. A company appoints 4 salesmen A, B, C and D and observes their sales in 3 season's summer, winter and Monsoon. The figures (in Lakhs of Rs) are given in the following tables:

Season	Salesmen			
	A	B	C	D
Summer	36	36	21	35
Winter	28	29	31	32
Monsoon	26	28	29	29

Carry out an analysis of Variance.

39. The following data represent the number of units of production per day turned out by 4 different workers using 5 different types of machines:

Worker	Machine type				
	A	B	C	D	E
1	4	5	3	7	6
2	6	8	6	5	4
3	7	6	7	8	8
4	3	5	4	8	2

On the basis of this information, can it be concluded that (i) the mean productivity is the same for different machine (ii) the workers do not differ with regard to productivity?

40. The numbers of automobiles arriving at 4 toll gates were recorded for a 2 hours time period (10 AM to 12 Noon) for each of six working days. the data are follows:

Day	Gate1	Gate2	Gate3	Gate4
Monday	200	228	212	301
Tuesday	208	230	215	305
Wednesday	225	240	228	288
Thursday	223	242	224	212
Friday	228	210	235	215
Saturday	220	208	245	200

Determine whether the rate of arrival (i) is same at each toll gate (ii) Differs significantly during the six days or not

41. The following tables gives the number of refrigerators sold by 4 salesmen in 3 months:

Months	Salesmen			
	I	II	III	IV
May	50	40	48	39
June	46	48	50	45
July	39	44	40	39

Determine whether (i) there is any difference in average sales made by the four salesmen (ii) the sales differ with respect to different months.

42. Four different drugs have been developed for a certain disease. These drugs are used in 3 different hospitals and the results, given below, show the number of cases of recovery from the disease per 100 people who have taken the drugs:

	D ₁	D ₂	D ₃	D ₄
H ₁	19	8	23	8
H ₂	10	9	12	6
H ₃	11	13	13	10

what conclusion can you draw based on an analysis of variance?

43. The following table gives the additional hours of sleep due to 3 soporofic drugs A, B, C tried on one patient each from 4 different age groups. Examine whether age has got any significant effect on the gain in sleep. Also examine whether the 3 drugs are similar in their effects or not

Drugs	Age group			
	30-40	40-50	50-60	60-70
A	2.0	1.2	1.0	0.3
B	1.1	0.8	0.0	-0.1
C	1.5	1.3	0.9	0.1

44. The following table gives the results of experiment on 4 varieties of a crop in 5 blocks of plots. Prepare the ANOVA table to test the significance of the difference between the yields of the 4 varieties.

Variety	B ₁	B ₂	B ₃	B ₄	B ₅
A	32	34	33	35	37
B	34	33	36	37	35
C	31	34	35	32	36
D	29	26	30	28	29

45. Analyse the variance in the following Latin square:

A 8	C 18	B 9
C 9	B 18	A 16
B 11	A 10	C 20

Replicates	1	2	3	4	5	6
1	18.5	15.7	16.2	14.1	13.0	13.6
2	11.7	14.25	12.9	14.4	14.9	12.5
3	15.4	14.6	15.5	20.3	18.4	21.5
4	16.5	18.6	12.7	15.7	16.5	18.0

47. Analyse the variance in the following Latin square:

B 20	C 17	D 25	A 34
A 23	D 21	C 15	B 34
D 24	A 26	B 21	C 19
C 26	B 23	A 27	D 22

48. A varietal trial was conducted on wheat with 4 varieties A, B, C, and D in a Latin square design. The plan of the experiment and the per plot yield are given below.

C 25	B 23	A 20	D 20
A 19	D 19	C 21	B 18
B 19	A 14	D 17	C 20
D 17	C 20	B 21	A 15

Analyse the data and interpret the result.

49. The following is the Latin square layout of a design when 4 varieties of seeds are tested. Set up the analysis of variance table and state your conclusions.

A 105	B 95	C 125	D 115
C 115	D 125	A 105	B 105
D 115	C 95	B 105	A 115
B 95	A 135	D 95	C 115

50. The table given below shows the yield of a certain crop in kgs per plot. The letters A, B, C, D refer to 4 different manurial treatments. Carry out an analysis of variances.

A 260	B 300	C 335	D 371
B 280	A 300	D 300	C 410
D 320	C 345	B 340	A 254
C 372	D 395	A 290	B 328

51. The following results were obtained in a textile experiment to compare the effects of sizing treatments A, B, C, and D on the number of warps breaking per hour. Is the difference between the treatments significant?

LOOM			
1	A 54	B 31	C 70
2	B 59	A 23	D 100
3	C 40	D 41	B 74
4	D 83	C 29	A 100
			B 28

52. An agricultural experiment on the Latin square plan gave the following results for the yield of wheat per acre, letters corresponding to varieties.

A 16	B 10	C 11	D 9	E 9
E 10	C 9	A 14	B 12	D 11
B 15	D 8	E 8	C 10	A 18
D 12	E 6	B 13	A 13	C 12
C 13	A 11	D 10	E 7	B 14

Discuss the variation of yield with each of the factors corresponding to the rows and columns

53. The following is a Latin square design of five treatments:

A 13	B 9	C 21	D 7	E 6
D 9	E 8	A 15	B 7	C 16
B 11	C 17	D 8	E 10	A 17
E 8	A 15	B 7	C 10	D 7
C 11	D 9	E 8	A 11	B 15

Analysis the data and interpret the results.

PART- A TWO MARKS QUESTION AND ANSWERS

1. What is the aim of the design of experiments?

Answer: A statical experiment in any field is performed to verify a particular hypothesis. The main aim of the design of experiments is to control the extraneous variables and hence to minimise the experimental error so that the results of the experiments could be attributed only to the experimental variables.

2. What do you mean by replication?

Answer: In a comparative experiment, in which the effects of different manures on yield are studied, each manure is used in more than one plot. In other words, we resort to replication which means repetition. It is essential to carry out more than one test on each manure in order to estimate the amount of the experimental error and hence to get some idea of the precision of the estimates of the manure effects.

3. Write down the format of the ANOVA table for two factors of classification

4. Write any two difference between RBD and LSD

5. Define Latin Square Design.

6. Define Analysis of Variance (ANOVA)

Answer: According to R.A.Fisher, analyse of variance (ANOVA) is the "separation of variance ascribable to one group of causes from the variance ascribable to other groups".

7. State the Null and Alternative hypotheses for a completely randomized design.

8. What is the purpose of blocking in a randomized block design?

9. Why a 2×2 Latin square is not possible? Explain.

Answer: Consider a $n \times n$ Latin square design, the degree of freedom for SSE is $(n-1)(n-2)$

When $n = 2$ degree of freedom = 0

So comparisons are not possible .Hence 2×2 Latin square is not possible

10. Define mean square.

11. Define completely randomized design.

12. Write the basic assumption in analysis of variance.

- ♣ The observation are random
- ♣ The observations are independent
- ♣ The sample are drawn from normal population
- ♣ Population variance are equal

13. Write the advantage of the Latin square design over the other design.

14. What are the advantage of a CRD

15. Discuss the advantages and disadvantages of randomized block design.

TESTS OF HYPOTHESES

1. The mean breaking strength of the cables supplied by a manufacturer is 1800 with a SD of 100. By a new technique in the manufacturing process, it is claimed that the breaking strength of the cable has increased. To test this claim, a sample of 50 cables is tested and it is found that the mean breaking strength is 1850. Can we support the claim at 1% LOS?
2. A sample of 100 students is taken from a large population. The mean height of the students in this sample is 160 cm. Can it be reasonably regarded that, in the population, the mean height is 165 cm, and the SD is 10 cm?
3. A random sample of 50 observations from the normal population gave an arithmetic mean of 32 units with a standard deviation of 2 units. Test whether the population mean is 30 at 1% level.
4. To test whether the arithmetic mean of population is 12, a random sample of size 32 was selected from the population. The sample mean was observed to be 64 units and the population variance is known to be 4 units. Carry out the test procedure at 1% LOS
5. A sample of 400 male students of a college is found to have a mean height of 171.38 cm. Can it be regarded as a sample from a large population with mean height 171.17 cm and standard deviation 3.30 cm.
6. A sample of 900 item is found to have a mean of 3.47 cm. Can it be reasonably regarded as a simple sample from a population with mean 3.23 cm and SD 2.31 cm?
7. A sample of 400 observations has mean 95 and SD 12. Could it be a random sample from a population with mean 98? What should be the maximum value of the population mean so that the sample can be regarded as one drawn from it almost certainly?
8. A manufacturer claims that, the mean breaking strength of safety belts for air passengers produced in his factory is 1275 Kg. A sample of 100 belts was tested and the mean breaking strength and SD were found to be 1258 and 90 Kg respectively. Test the manufacturer's claim at 5% LOS
9. Test made on the breaking strength of 10 pieces of a metal gave the following result: 578, 572, 570, 568, 572, 570, 570, 572, 596 and 584 Kg. Test if the mean breaking strength of the wire can be assumed as 577 Kg.
10. A machinist is expected to make engine parts with axle diameter of 1.75 cm. A random sample of 10 parts shows a mean diameter 1.85 cm with an SD of 0.1 cm. On the basis of this sample, would you say that the work of the machinist is inferior?
11. The mean lifetime of a sample of 25 bulbs is found as 1550 hours with a SD of 120 hours. The Company manufacturing the bulbs claims that the average life of their bulbs is 1600 h. Is the claim acceptable at 5% LOS?
12. A certain injection administered to each of 12 patients resulted in the following increases of blood pressure: 5, 2, 8, -1, 3, 0, 6, -2, 1, 5, 0, 4. Can it be concluded that the injection will be, in general, accompanied by an increase in BP?
13. A machine is expected to produce nails of length 7 cm. A random sample of 10 nails was found to measure the following lengths: 7.2, 7.3, 7.1, 6.9, 6.8, 6.5, 6.9, 6.8, 7.1, and 7.2 cm. On the basis of this sample, what can be said about the reliability of the machine?
14. Verify whether the population mean is equal to 65 at 5% level for the following data. 60, 63, 65, 66, 68, 69, 61, and 60.
15. Verify whether the population mean is greater than 25 at 1% level for the following data 10, 20, 30, 40, and 50.
16. A soap manufacturing company was distributing a particular brand of soap through a large number of retail shops. Before a heavy advertisement campaign, the mean sale per soap was 140 dozens. After the campaign a sample of 26 shops was taken and the mean sales figure was found to be 147 dozens with a standard deviation of 16. Can you consider the advertisement effective at 5% level of significance?

17. A machine is designed to produce insulating washers for electrical devices of average thickness of 0.025 cm. A random sample of 10 washers was found to have an average thickness of 0.024 cm with a standard deviation of 0.002 cm. Test the significance of the deviation value of t for 9 df at 5% level of significance.
18. A random sample of 16 values from a normal population showed a mean of 41.5 inches and the sum of squares of deviation from this mean equal to 135 square inches. Show that the assumption of a mean of 43.5 inches for the population is not reasonable. Obtain 95% fiducial limits for the same.
19. In a random sample of size 500, the mean is found to be 20. In another independent sample of size 400, the mean is 15. Could the sample have been drawn from the same population with SD 4?
20. A simple sample of height of 6400 English men has a mean of 170 cm and a SD of 6.4 cm. While a simple sample of heights of 1600 Americans has a mean of 172 cm and a SD of 6.3 cm. Do the data indicate that Americans are, on the average, taller than the Englishmen?
21. Test the significance of the difference between the means of the samples, drawn from two normal populations with the same SD using the following data:

	Size	mean	SD
Sample 1	100	61	4
Sample 2	200	63	6

22. The average mark scored by 32 boys is 72 with a SD of 8, while that for 36 girls is 70 with a SD of 6. Test at 1% LOS whether the boys perform better than girls.
23. During a countrywide investigation, the incidence of TB was found to be 1%. In a college with 400 students, 5 are reported to be affected whereas in another college of 1200 students, 10 are found to be affected. Does this indicate any significant difference?
24. The standard deviation of the marks of the students in section A and section B are known to be 2.46 and 4.32 respectively. From section A, a sample of 40 students was selected. The arithmetic mean of their marks was known to be 93. From section B, a random sample of size 45 was selected and the arithmetic mean is observed to be 95. Test whether the average performance of students in section B is superior to that of section A at 5% LOS.
25. The Standard deviation of the population A and B are known to be 1.36, 2.36 respectively. To verify whether the population mean are equal. A random sample of size 100 was selected from population A. The sample mean was found to be 56. A random sample of size 120 was selected from population. The arithmetic mean was found to be 48. Test whether the difference between the mean at 5% LOS.
26. The means of two samples of 1000 and 2000 members are 67.5 and 68.0 inches respectively. Can the sample be regarded as drawn from the same population of standard deviation 2.5 inches?
27. A college conducts both day and night classes intended to be identical. A sample of 100 day students yields examination result as under. Mean 72.4 and SD 1.48. A sample of 200 night students yields examination results as under. Mean 73.4 and SD 1.79 are the two means statically equal to 10% level.
28. Random samples of 1000 workers from south India show that their mean wages are Rs.47 per week with a standard deviation of Rs.28. A random sample of 1500 workers from North India gives a mean wage of Rs.49 per week with standard deviation of Rs.40. Is there any significant difference between their mean levels of wages?
29. The mean yield of wheat from a district A was 210 Kgs with standard deviation 10 Kgs per acre from a sample of 100 plots. In another District B the mean yield was 220 Kgs with standard deviation 12 Kg from a sample of 150 plots. Assuming that the standard deviation of the yield in the entire area was 11 Kg, test whether there is any significant difference between the mean yields of crops in the two districts.
30. A random sample of 50 male employees is taken at the end of the year and the mean number of hours of absents of the year is found to be 63 hrs. A similar sample of 50 female employees has mean of 66 hrs. Could these samples be drawn from a population with the same mean and standard deviation 10 hrs? State clearly the assumption you made.

31. Test whether the population means are identical at 1% level

Sample 1 : 10 11 16 20 23

Sample 2 : 14 16 20 23 10 12

32. Given the following information in the usual notations $n_1 = 7$, $n_2 = 6$, $s_1^2 = 6.21$, $s_2^2 = 5.23$, $\bar{x} = 30$, $\bar{y} = 28$ test the hypothesis that the two samples have come from population having equal means.

33. The average number of articles produced by two machines per day is 200 and 250 with standard deviation 20 and 25 respectively on the basis of records of 25 days production. Can you regard both the machines equally efficient at 1% level of significance?

34. A producer confesses that only 12% of the item manufactured by him will be defective. To test his claim a random sample of 150 items were selected and 26 items were noted to be defective. Test the producer's claim at 5% level of significance.

35. A producer confesses that 22% of the items manufactured by him will be defective. To test his claim a random sample of 80 items was selected and known to contain 13 defective items. Test the validity of the producer's at 1% level of significance.

36. A coin is thrown 400 times and is found to result in 'Head' 245 times. Test whether the coin is a fair one.

37. A coin is thrown 100 times. The number of heads was observed to be 46. Test whether the proportion of heads in the population is 0.5 at 1% level of significance.

38. A die is rolled 200 times. Getting an even number in a trial is termed as a success out of 200 trials 132 trials resulted in success. Test whether the die is unbiased at 1% level of significance.

39. 40 people were attacked by a disease and only 36 survived. Will you reject the hypothesis that the survival rate, if attacked by this disease, is 85% in favour of hypothesis that it is more at 5% level of significance?

40. A dice was thrown 9000 times and of these 3200 yielded a 3 or 4. Is this consistent with the hypothesis that the dice was unbiased.

41. In a sample of 400 burners there were 12 whose internal diameters were not within tolerance. Is this sufficient evidence for conducting that the manufacturing process is turning out more than 2% defective burners?

42. In a random sample of 400 persons from a large population, 120 are females can it be said that males and females are in the 5:3 in the population. Use 5% level of significance.

43. A manufacturer claimed that at least 95% of the equipment which he supplied to a factory conformed specifications. An examination of a sample of 200 pieces of equipment revealed that 18 were faulty. Test his claims at a significance of 0.05.

44. A machine produces 16 defective bolts in a batch of 500 bolts. After the machine is overhauled, it produces 3 defective bolts in a batch of 100 bolts. Has machine improved?

45. A machine produced 20 defective articles in a batch of 400. After overhauling it produced 10 defectives in a batch of 300. Has the machine improved.

46. Before an increase in excise duty on tea, 800 people out of a sample of 1000 were consumers of tea.

After the increase in duty, 800 people were consumers of tea in a sample of 1200 persons. Find whether there is significant decrease in the consumption of tea after the increase in duty.

47. 15.5% of a random sample of 1600 undergraduates was smokers, whereas 20% of a random sample of 900 postgraduates was smokers in a state. Can we conclude that less number of undergraduates are smokers than the postgraduates?

48. On a certain day, 74 trains were arriving on time at Delhi station during the rush hours and 83 were late. At New Delhi there were 65 on time and 107 late. Is there any difference in proportions arriving on time at two stations?

49. A machine put out 20 imperfect items in a sample of 500. After the machine was overhauled it put out 5 imperfect items in a batch of 150. Has the machine being improved after overhauling?

PANIMALAR INSTITUTE OF TECHNOLOGY
QUESTION BANK - UNIT-4 DESIGN OF EXPERIMENTS

DEPARTMENT OF MATHEMATICS

14

50. During a countrywide investigation, the incidence of TB was found to be 1%. In a college with 400 students, 5 are reported to be affected whereas in another college of 1200 students, 10 are found to be affected. Does this indicate any significant difference?
51. A random sample of 600 men chosen from a certain city contained 400 smokers. In another sample of 900 men chosen from another city, there were 450 smokers. Do the data indicate that (i) the cities are significantly different with respect to smoking habit among men? And (ii) the first city contains more smokers than the second?
52. The following data is collected on two characters. Based on this, can you say that there is no relation between smoking and literacy?

	Smokers	Non-smokers
Literates :	83	57
Illiterates:	45	68

53. Two batches each of 12 animals are taken for test of inoculation. One batch was inoculated and the other batch was not inoculated. The numbers of dead and surviving animals are given in the following table for both cases. Can the inoculation be regarded as effective against the disease? Make Yate's correction for continuity of χ^2 .

Inoculated	Dead	Survived	Total
	2	10	12
Not inoculated	8	4	12
Total	10	14	24

54. A total number of 3759 individuals were interviewed in a public opinion survey on a political proposal. Of them, 1872 were men and the rest women. A total of 2257 individuals were in favour of the proposal and 917 were opposed to it. A total of 243 men were undecided and 442 women were opposed to the proposal. Do you justify or contradict the hypothesis that there is no association between sex and attitude?

55. The following table gives for a sample of married women, the level of education and the marriage adjustment score:

Level of Education	Very low	Marriage adjustment			Total
		Low	High	Very High	
College	24	97	62	58	241
High Scholl	22	28	30	41	121
Middle Scholl	32	10	11	20	73
Total	78	135	103	119	435

Can you conclude from the above data that the higher the level of education, the greater is the degree of adjustment in marriage?

56. A certain drug is claimed to be effective in curing cold. In an experiment on 500 persons with cold, half of them were given the drug and half of them were given the sugar pills. The patient's reactions to the treatment are recorded in the following table:

Drug	Helped	Marriage adjustment		Total
		Harmed	No effect	
Drug	150	30	70	250
Sugar pills	130	40	80	250

on the basis of this data, can it be conclude that the drug and sugar pills differ significantly in curing cold?

57. A survey of radio listener's preference for two types of music under various age groups gave the following information.

Type of music	Age group		
	19-25	26-35	above-36
Carnatic music	80	60	90
Film music	210	325	44

Indifferent	16	45	132
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is preference for type of music influenced by age?

58. The table given below shows the results of a survey In which 250 respondents were classified according to the levels of education and attitude towards student's agitation in a certain town. Test whether the two criteria of classification are independent.

Education	Attitude		
	Against	Neutral	For
Middle Scholl	40	25	5
High Scholl	40	20	5
College	30	15	30
Postgraduate	15	15	10

Test whether the two criteria of classification are independent.

59. The following information was obtained in a sample of 40 small general shops:

	Shops in Urban areas	Shops in Rural area
Owned by men	17	18
Owned by Women	3	12

Can it be said that there are more women owners in rural areas than in urban areas? Use Yate's correction for continuity.

60. The following table shows the distribution of digits in the numbers chosen at random from a telephone directory:

Digit	0	1	2	3	4	5	6	7	8	9	Total
Frequency	1026	1107	997	966	1075	933	1107	972	964	853	10,000

Test whether the digits may be taken to occur equally frequently in the directory.

61. The following data give the number of air-craft accidents that occurred during the various day of a week.

Day	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
No of Accidents	15	19	13	12	16	15

Test whether the accidents are uniformly distributed over the week.