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22MA401-PROBABILITY AND STATISTICS

UNIT-1V - DESIGN OF EXPERIMENTS

PART-A

1. What do you understand by "Design of an experiment"?

   Solution:

   The design of experiment may be defined as the logical construction of the experiment in which the degree of uncertainty with which the inference is drawn is well defined.

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

   Solution:

   The aim of design of experiment is to control the extraneous variables and hence to minimize the experimental error so that the results of the experiments could be attributed only to the experimental variables.

3. State the basic principles of design of Experiments.

   Solution:

   The basic principles of the design of the experiment are

   (i) Randomization
   (ii) Replication
   (iii) Local control

4. Name some basic designs of experiment.

   Solution:

   (i) Completely randomized design(CRD)
   (ii)Randomized block design(RBD)
   (iii) Latin square design(LSD).

5. What is ANOVA?

   Solution:

   The technique of analysis is referred to as ANOVA. A table showing the source of variation, the sum of squares, the degrees of freedom, mean squares and the formula for F-test is known as the ANOVA table.

6. State the assumptions involved in ANOVA(Analysis of variance).

   Solution:

   (i) The samples are drawn from normal population.
   (ii) The variances for the population from which samples have been drawn are equal.

7. Define CRD.

   Solution:

   This is the simplest of all designs. In design treatments are allocated at random to the experimental unit over the entire experimental material.

8. Write down the ANOVA table for one-way classification(CRD).

   Solution:

Source of variation(S.V.)	Sum of squares (S.S)	Degreesof freedom(d.f)	Mean sum of squares (M.S)	Variance ratio (F>1)
Between columns	SSC	h-1	SSC/ h-1	$F = \frac{SSC/h-1}{SSW/N-h}$
Within columns	SSW	N-h	SSW/ N-h	
Total	TSS	N-1		

Here N= total no. of values in the table
T= Sum of all values in the table

$$TSS = \sum\sum x_{ij}^2 - \frac{T^2}{N}$$

$$SSC = \sum \frac{T_i^2}{n_i} - \frac{T^2}{N}$$

$$SSW = TSS - SSC$$

9. Define:RBD(Two way classification).

Solution:

Suppose we wish to test the effect of k fertilizing treatments on the yield of crops. We divide the plot into h blocks each block containing k blocks. And the k treatments are given to the h blocks such that each treatment occurs only once in each block. This way designing the experiment is called RBD.

10. Write down the ANOVA table for Two-way classification(RBD).

Solution:

Source of variation(S.V.)	Sum of squares (S.S)	Degrees of freedom(d.f)	Mean sum of squares (M.S)	Variance ratio (F>1)
Between rows	SSR	h-1	SSR/ h-1	$F_R = \frac{SSR/h-1}{SSE/(h-1)(K-1)}$
Between columns	SSC	K-1	SSC/ K-1	$F_C = \frac{SSC/k-1}{SSE/(h-1)(K-1)}$
Remainder or Error	SSE	(h-1)(k-1)	SSE/(h-1)(k-1)	

Total	TSS	hk-1		

Here N= total no. of values in the table

T= Sum of all values in the table

$$TSS = \sum\sum x_{ij}^2 - \frac{T^2}{N}$$

$$SSR = \frac{1}{k}\sum T_i^2 - \frac{T^2}{N}$$

$$SSC = \frac{1}{h}\sum T_j^2 - \frac{T^2}{N}$$

$$SSE = TSS - SSR - SSC$$

11. Define LSD (Three way classification).

Solution:

Here n^2 plots are taken and arranged in the form of a nxn square. Then n treatments are given to these plots such that each treatment occurs only once in each row and column. This way of designing is called as LSD.

12. Write down the ANOVA table for Three-way classification(LSD).

Solution:

Source of variation(S.V.)	Sum of squares (S.S)	Degrees of freedom(d.f)	Mean sum of squares (M.S)	Variance ratio (F>1)
Between rows	SSR	n-1	SSR/ n-1	$F_R = \frac{SSR/n-1}{SSE/(n-1)(n-2)}$
Between columns	SSC	n-1	SSC/ n-1	$F_C = \frac{SSC/n-1}{SSE/(n-1)(n-2)}$
Between treatments/letters	SST	n-1	SST/ n-1	$F_T = \frac{SSt/n-1}{SSE/(n-1)(n-2)}$
Remainder or Error	SSE	(n-1)(n-2)	SSE/(n-1)(n-2)	
Total	TSS	n^2-1		

Here n= no. of rows/columns

T= Sum of all values in the table

$$TSS = \sum\sum x_{ij}^2 - \frac{T^2}{n^2}$$

$$SSR = \frac{1}{n}\sum T_i^2 - \frac{T^2}{n^2}$$

$$SSC = \frac{1}{n}\sum T_j^2 - \frac{T^2}{n^2}$$

$$SST = \frac{1}{n}\sum T_k^2 - \frac{T^2}{n^2}$$

$$SSE = TSS - SSR - SSC - SST$$

13.State any two advantages of a Completely Randomized Experimental Design.

Solution:

(i) It is easy to lay out the design.

(ii) It allows for complete flexibility. Any number of factor classes and replications may be used.

14.Compare one-way classification model with two-way classification model.

Solution:

CRD	RBD
It has a simple lay out.	It has a simple layout but it is more efficient than CRD
Analysis of the design is simple as it results in a one-way classification of analysis of variance	Analysis is possible even if some observations are missing
The experimental error is large compared to RBD	The experimental error is less compared to LSD

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

Solution:

Merits:

1. It has a simple layout
2. Analysis is possible even if some observations are missing.
3. It is flexible and so any number of treatments and any no. of replication may be used.

Demerits:

1. If the number of treatments is large then the size of the blocks will increase. This may cause heterogeneity within the blocks.
2. The shape of the experimental material or plot should be retanglular.

16. What are the advantages of a Latin square design?

Solution:

1. LSD controls variation in two direction of experimental as rows and coumns resulting in the reduction of experimental error.
2. The analysis of the design results in a three way classification of analysis of variance.
3. The analysis remains relatively simple even with missing data.

17. Compare RBD AND LSD.

Solution:

LSD	RBD
It is suitable for small number of treatments between 5 and 12.	No such restrictions.
The no. of rows and columns must be equal	No such restrictions

Experimental area must be a square	Suitable if it is a square or a rectangle
Variations is controlled in two directions which reduces the experimental error	Variations is controlled in one direction

18. Why a 2x2 Latin square is not possible? Explain.

Solution:

For a 2x2 latin square design the degrees of freedom for sum of squares of treatments/letters is 0. Hence it is not possible.

PART-B

1. The following are the number of mistakes made in 5 successive days by 4 Technicians working for a photographic laboratory test at a level of significance α=**0.01**. Test whether the difference among the four sample means can be attributed to chance.

Technician			
I	II	III	IV
6	14	10	9
14	9	12	12
10	12	7	8
8	10	15	10
11	14	11	11

2. A completely randomized 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 treatment effects.

3. Analyse the following RBD and find your conclusion.

TREATMENTS

BLOCKS	T_1	T_2	T_3	T_4
B_1	12	14	20	22
B_2	17	27	19	15
B_3	15	14	17	12
B_4	18	16	22	12
B_5	19	15	20	14

4. Four varitiesA, B,C, D of a fertilizer are tested in a RBD with 4replications. The plot yields in pounds areas follows:

A12	D20	C16	B10
D18	A14	B11	C14
B12	C15	D19	A13
C16	B11	A15	D20

Analyse the experimental yield.

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

		MachineType			
		A	B	C	D
Workers	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

(i)Test whether the mean production is the same for the different machine types.
(ii)Test whether the 5 men differ with mean productivity.

6. Analyse the following Latin square.experiment

A12	D20	C16	B10
D18	A14	B11	C14
B12	C15	D19	A13
C16	B11	A15	D20

7. Analyse the variance in the Latin square of yields(in kgs) of paddy where P,Q,R,S Denote the different methods of cultivation:

S122	P121	R123	Q122
Q124	R123	P122	S125
P120	Q119	S120	R121
R122	S123	Q121	P122

Examine whether different method of cultivation have significantly different yields.