

3 (Sem-6) STS M 2

2014

STATISTICS

(Major)

Paper : 6.2

(Design of Experiments)

Full Marks : 60

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

1. Answer the following : 1×7=7

- (a) Define analysis of variance.
- (b) Name the three basic principles of design of experiment.
- (c) Name any two techniques which are used to reduce the error in design of experiment.
- (d) Name the design of experiment where all the three basic principles are used.

14A—300/1330

(Turn Over)

(2)

- (e) Name the design where main effect is confounded.
- (f) How many two-factor interactions are there in 2^4 -factorial experiment?
- (g) With four treatments A, B, C and D what would be degrees of freedom for total sums of square in a Latin square design?

2. Answer the following : 2×4=8

- (a) Can you apply the missing plot technique in a completely randomized design? Give reasons.
- (b) In a randomized block design, the yield of the plot for 1st treatment and 1st block is 50 kg. Mean of the 1st treatment is 25 kg, mean of the 1st block is 12 kg, grand mean is 10 kg. Find the estimate of error component for the corresponding plot.
- (c) Define the term mutually orthogonal contrast in connection with a 2^3 -factorial experiment.
- (d) Write the linear model of an one-way classified data when there is a concomitant variable.

14A—300/1330

(Continued)

(3)

3. Answer any three parts : 5×3=15

- (a) For a randomized block design, estimate the effect due to treatment. Also write the analysis of variance table. 4+1=5
- (b) Explain how analysis of variance can be used for testing the linearity of regression. 5
- (c) Explain the concept of total, partial and balanced confounding with the help of 2^4 -factorial experiment. 5
- (d) Discuss the efficiency of LSD in comparison to RBD. 5
- (e) Show that in a 2^3 -factorial design, different main effects and interaction effects are mutually orthogonal contrast. What is the implication of this result? 4+1=5

4. Answer any three parts : 10×3=30

- (a) Starting from a linear model, estimate different effects in a Latin square design. Also write the break-up of total sums of square and degrees of freedom. 7+1½+1½=10
- (b) Discuss how you would allot the treatments in a split-plot design. Also discuss briefly its analysis. 5+5=10

14A—300/1330

(Turn Over)

(4)

(c) Discuss the analysis of a two-way classified data with a concomitant variable. 10

(d) Find the standard error of difference between two treatment means when there is a missing observation in a randomized block design. 10

(e) Suppose you want to confound the four-factor interaction $ABCD$ in a 2^4 -factorial experiment with the factors A, B, C and D , in a replication.

Write the contents of the treatment combinations of the blocks. Which one is called key block? Can you confound $ABCD$ and ABC simultaneously in a replication? Give reasons. Suppose you want to confound the three-factor interactions ABC and BCD in a replication. Then write down the contents of different blocks. $3+1+2+4=10$

(f) (i) Write about the violation of assumptions in analysis of variance. 5

(ii) Explain how one can get a balanced confounding in a 2^5 -factorial experiment in 5 replications. 5

14A—300/1330

3 (Sem-6) STS M 2

Total No. of printed pages = 5

3 (Sem 6) STS M 2

2015

STATISTICS

(Major)

Theory Paper : M-6.2

Full Marks – 60

Time – Three hours

The figures in the margin indicate full marks for the questions.

1. Answer the following : 1×7=7
- (a) What do you mean by 'Design of Experiments' ?
- (b) Name the simplest design making use of all the three basic principles of design of experiments.
- (c) What are the assumptions made about the error component in the analysis of variance technique ?

[Turn over

(d) In a fixed effects model, the hypothesis about the treatments, which is under test, is

(i) $\sigma_t^2 = 0$ (ii) $\tau_t = 0 \forall t$

(iii) $\sum_t \tau_t = 0$

(iv) None of these

(Choose the correct answer)

(e) What will be the error d.f. in an RBD with 4 blocks comparing 5 treatments, having one missing observation ?

(f) What is a contrast ?

(g) What is a 2^n factorial experiment ?

2. Answer the following questions briefly : $2 \times 4 = 8$

(a) Explain the concept of Analysis of Variance.

(b) Explain Fixed-effects. Random-effects and Mixed models.

Or

Explain briefly how Regression model and Analysis of Covariance model is obtained from a simple linear model.

(c) Give the layout of a $P \times P$ Latin Square Design.

(d) With 3 factors A, B, C, each at 2 levels, write down the factorial effects. Also give the layout of a replication if Interaction ABC is confounded.

3. Answer any three of the following questions : $5 \times 3 = 15$

(a) Explain the basic principles of Design of Experiments.

(b) Describe how the ANOVA technique can be used to test for multiple linear regression model.

(c) What is missing plot technique ? Find the estimate of the missing observation in a Randomised Block Design.

(d) What are factorial experiments ? Enumerate the advantages of factorial experiments over single factor experiments.

(e) Explain how you can achieve a balanced design in a 2^4 factorial experiment.

Turn over

Answer any three of the following questions :

- (a) What is analysis of covariance ? Discuss the analysis of a one-way classified data with a concomitant variables. $10 \times 3 = 30$
- (b) Describe the analysis of a Randomised Block Design under the following heads : $2+8=10$
- (i) Linear model used and the estimation of treatment effects. $4+4+2=10$
- (ii) Expectation of mean squares of treatment effects.
- (iii) Analysis of Variance Table.
- (c) Find the standard error of the difference between two treatment means when one of them has a missing observation, in a Latin Square Design. Also write the expression of standard error when there is no missing observation under any of the treatments. $9+1=10$
- (d) Describe the layout and give an outline of the analysis of a Split Plot design. $4+6=10$

- (e) A factorial experiment with 4 factors A, B, C, D at 2 levels each is arranged in 5 replications of 4 blocks of 4 plots each. For each replication the elements of one of the blocks is a, b, abcd, cd. Identify the confounding subgroup and give the complete layout of the 4 blocks in a replication. Also give an outline of the analysis of the design. 10

Or

- Describe the complete analysis of a 2^3 partially confounded design in 4 replications of 2 blocks of 4 plots each (different effects being confounded in each replication).
- (f) Write explanatory notes on any two : $5+5=10$
- (i) Effect of violation of the assumptions made in the Analysis of Variance Technique.
- (ii) Confounding.
- (iv) Efficiency of designs with reference to the relative efficiency of RBD with respect to CRD.

2016

STATISTICS

(Major)

Paper : 6.2

(Design of Experiments)

Full Marks : 60

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Answer the following : 1×7=7

- (a) Define the term replication.
- (b) State when one should use the completely randomised design (CRD).
- (c) Name the design where the main effect is confounded.
- (d) State whether the following statement is correct :
"Analysis of covariance is a mixture of analysis of variance and regression analysis."

(e) Suppose you want to apply four treatments in a Latin square design. Then state the degrees of freedom for error component.

(f) Define the term experimental unit.

(g) Suppose in a 2^4 -factorial experiment with the factors A, B, C and D each at two levels, we want to confound the interaction effects ABC and BCD in a replication. Name the other factor which is also confounded.

2. Answer the following : 2x4=8

(a) Suppose in two-way classified data with two factors A and B, we have the following :

A →	A ₁	A ₂	A ₃
B ↓			
B ₁	y ₁₁ = 5	y ₁₂ = 6	y ₁₃ = 9
B ₂	y ₂₁ = 8	y ₂₂ = 7	y ₂₃ = 2
B ₃	y ₃₁ = 6	y ₃₂ = 10	y ₃₃ = 12

Find the estimate of the error value corresponding to $y_{22} = 7$.

(b) Can we use the missing plot technique in a CRD? Give reason to your answer.

(c) Show that in a 2^3 -factorial design with the factors A, B and C each at the two levels, viz., 0, 1, main effect A and interaction effect AB are orthogonal contrast.

(d) Suppose in randomised block design (RBD) G_i and B_j denote the grand total, total of i th treatment ($i = 1, 2, \dots, p$) and total of j th block ($j = 1, 2, \dots, q$) respectively. Then show that sum of square due to treatment is given by

$$\sum_{i=1}^p \frac{T_i^2}{q} - \frac{G^2}{pq}$$

Or

State any two assumptions of analysis of variance.

3. Answer any three of the following : 5x3=15

(a) Starting from a suitable linear model, estimate the treatment effect in a randomised block design (RBD).

(b) Describe how analysis of variance technique can be used to test the linearity regression.

(c) Explain the term confounding with the help of an example.

(4)

- (d) Find the estimate of the missing plot in an RBD.
- (e) Define experimental error. What methods are adopted to increase the accuracy of an experiment?
4. Answer any three of the following : $10 \times 3 = 30$
- (a) Discuss the analysis of a Latin square design (LSD). 10
- (b) Suppose you want to confound the interaction effects ABC and BDE in a 2^5 -factorial experiment with the factors A, B, C, D and E each at two levels, in a replication. Write down the contents of the control block. Taking 4 such replications, write the breakup of the degrees of freedom. State how you can achieve a balanced design in a 2^5 -factorial experiment. $5+3+2=10$
- (c) Discuss the analysis of a split-plot design in detail. 10
- (d) Write the linear model of a two-way classified data with a concomitant variable. Also write down the table(s) for finding the true treatment sums of square. $2+8=10$

A16/385

(Continued)

(5)

- (e) Suppose in a 2^4 -factorial experiment with the factors A, B, C and D each being applied at two levels, you want to confound $ABCD$ in a replication. Then write down the contents of the control block. Taking 4 such replications, discuss its analysis. $3+7=10$
- (f) Describe the layout of a 2^3 -experiment where all the interactions are partially confounded. In such a case, indicate d.f.s. and sum of squares (SS) for all the components of treatment SS. 10

A16-400/385

3 (Sem-6) STS M 2

2017

STATISTICS

(Major)

Paper : 6.2

(Design of Experiments)

Full Marks : 60

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

1. Answer the following as directed : $1 \times 7 = 7$

(a) The equality of means is tested in analysis of variance.

(State true or false)

(b) Replication in a design of experiment means

(i) block size

(ii) number of treatments

(iii) number of times a treatment is repeated

(iv) number of plots

(Choose the correct option)

A7/708

(Turn Over)

(c) Which of the following statements is correct for completely randomized design?

(i) It has two principles—replication and randomization only.

(ii) It has two principles—replication and local control only.

(iii) It has two principles—randomization and local control only.

(iv) It has all the three principles replication, randomization and local control.

(Choose the correct option)

(d) While analysing the data of a $k \times k$ Latin square design, the degree of freedom for error is _____.

(Fill in the blank)

(e) For a 2^2 -factorial experiment in an r -randomised block, the sum of squares for the main effect A in the analysis of variance table is _____.

(Fill in the blank)

(f) What is a treatment contrast?

(g) In the linear model of analysis of variance, the error part is assumed to be distributed as

(i) $N(\mu, \sigma^2)$

(ii) $N(0, \sigma^2)$

(iii) $N(\mu, 0)$

(iv) $N(0, 1)$

(Choose the correct option)

$2 \times 4 = 8$

2. Answer the following :

(a) In an RBD with 6 treatments and 5 blocks, the following results were obtained :

MSB = 20, MST = 25, TSS = 245

Complete the ANOVA table.

(b) Explain why there cannot be a 2×2 Latin square design.

(c) Show that for 2^3 -factorial experiment, the main effect A and interaction effect AB are mutually orthogonal contrasts.

(d) In a 2^4 -factorial experiment, the key block is given by

(1), ab, cd, abcd

Identify the confounded effect(s).

(4)

3. Answer any three of the following :

5x3=15

- (a) In ANOVA testing for one-way classification (for fixed effect model), if the null hypothesis $H_0 : \mu_1 = \mu_2 = \dots = \mu_k$ is rejected, how will you proceed to test the significance of the difference between any two treatment means?
- (b) Explain the basic principles of good experimental design giving brief explanatory note for each.
- (c) Derive the expressions to measure the efficiency of Latin square design over a randomised block design when rows are used as blocks.
- (d) Prove that in a 2^4 -factorial experiment in 4 blocks of 4 plots, it is impossible to avoid first-order interaction among the three that are confounded. Also give a scheme of balanced design using such blocks.
- (e) Explain the concepts of partial, total and balanced confoundings in factorial experiments.

(5)

4. (a)

Derive the expected values of mean squares for two-way classified data with one observation per cell under the fixed effect mathematical model. Also show that they provide unbiased estimate of error variance. 10

Or

Discuss the analysis of covariance technique in a two-way classified data. 10

(b)

What do you understand by a 'missing plot' in a design of experiment? How would you estimate a missing value in Latin square design? Give an outline of the analysis of variance of a $p \times p$ Latin square design involving a single missing plot. 10

Or

Discuss the analysis of partial confounding in a 2^4 -factorial experiment. 10

(c) Find the standard error of difference between two treatment means, when one of them has a missing observation in a randomised block design. 10

Or

Discuss how analysis of variance technique can be used to test for multiple linear regression model. 10

3 (Sem-6) STS M 2

2018

STATISTICS

(Major)

Paper : 6.2

(Design of Experiments)

Full Marks : 60

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

1. Answer the following as directed : $1 \times 7 = 7$

(a) The linear mathematical model used for analysis of variance is _____.

(Fill in the blank)

(b) The plots in a randomized block design should be homogeneous _____.

(Fill in the blank)

(2)

(c) If the degrees of freedom for error sum of squares in Latin square design is 6, then the order of the design is

- (i) 3×3
- (ii) 4×4
- (iii) 5×5
- (iv) 6×6

(Choose the correct option)

(d) For a 2^2 -factorial experiment in r randomized blocks, the sum of squares for the effect A in the analysis of variance table is _____.

(Fill in the blank)

(e) Analysis of variance was developed by

- (i) Karl Pearson
- (ii) R. A. Fisher
- (iii) Irving Fisher
- (iv) G. W. Snedecor

(Choose the correct option)

8A/915

(Continued)

(3)

(f) The method of confounding is a device to reduce the size of

- (i) experiments
- (ii) replications
- (iii) blocks
- (iv) All of the above

(Choose the correct option)

(g) If σ_1^2 is the error variance of design-1 and σ_2^2 of design-2 utilizing the same experimental material, the efficiency of design-1 over design-2 is

- (i) $\frac{1}{\sigma_1^2} / \frac{1}{\sigma_2^2}$
- (ii) $\frac{1}{\sigma_2^2} / \frac{1}{\sigma_1^2}$
- (iii) σ_1^2 / σ_2^2
- (iv) None of the above

(Choose the correct option)

8A/915

(Turn Over)

2. Answer the following :

2x4=8

- (a) State some applications of analysis of variance.
- (b) What do you understand by randomization in experimental design?

(c) Write the linear model of one-way classified data when there is a concomitant variable.

(d) In a partially confounded 2^3 -factorial experiment, the control blocks of two replications are given below :

(i)	(1)	a	bc	abc
(ii)	(1)	b	ac	abc

Identify the confounded effects and write down the other blocks of the replications.

3. Answer any three of the following :

5x3=15

(a) What do you understand by the principle of local control? What are its uses in design of experiment?

(b) Explain how analysis of variance can be used for testing the linearity of regression.

(c) What is missing plot technique? Find the estimate of the missing observation in a randomized block design.

(d) Describe the factorial method of experimentation. Stating its advantages over a simple experiment, explain the situation where it could be used.

(e) Suppose in a 2^4 -design, the highest order interaction has been confounded. Write down the contents of different sub-blocks. Also write the breakup of degrees of freedom supposing you have four similar replications.

(6)

4. Answer all questions :

(a) Give the layout and analysis of Latin square design. Explain why the number of treatments tested in LSD should not be less than three.

10

Or

Describe the layout and give an outline of the analysis of a split plot design.

(b) Suppose in a 2^4 -design, the effects ABC and ABD are confounded. Write down the contents of the control block. Taking four such replications, discuss the analysis of such a design.

10

Or

Derive the expression to measure the efficiency of Latin square design over a randomized block design when—

(i) rows are used as blocks;

(ii) columns are used as blocks.

(c) (i) Write explanatory notes on :

10

(1) Confounding

(2) Analysis of covariance

(7)

(ii) Answer the following :

10

(1) Explain how one can get a balanced confounding in a 2^5 -factorial experiment in five replications.

(2) Write about the effect of violation of the assumptions made in analysis of variance technique.
