M. C. CHAKRABARTI, *Mathematics of Design and Analysis of Experiments*. Asia Publishing House, Bombay, London and New York, (Distributed in U.S.A. by Taplinger Publishing Co., New York) 1962. $5.50 120 pp.

Review by OSCAR KEMPTHORNE

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The book covers the substance of 12 lectures given by Professor Chakrabarti at Maharaja Sayajirao University of Baroda in the years 1954 to 1956, and is a very succinct presentation of the intermediate knowledge on the design of experiments from the point of view of normal distribution of errors.

The first chapter on Linear Estimation is the basis for the whole book. The subject is given entirely by matrix manipulation. The mode of presentation is very successful for the most part, but is forced in some cases. The proofs of theorems with $y = A\theta + e$, A being $n \times p$ of rank r, are based on picking out a set of r linearly independent columns of A, and writing a solution in terms of these. A better presentation would have been in terms of conditional inverses or projection operators. As regards tests of hypotheses the presentation is not clear in that Cochran's rule is used to obtain the usual F distribution, but then the reduction of the linear hypotheses to canonical form is done independently, from which the general non-null distribution of the criterion could have been derived very easily, but was not. Tests involving several linear functions of the parameters involve rather tedious matrix manipulations, using the general rule that if

$$\Lambda\theta = c,$$

where Λ is $k \times p$ of rank k, and the elements of $\Lambda\theta$ are estimable, then

$$(\Lambda\hat{\theta} - c)'[(1/\sigma^2)V(\Lambda\hat{\theta})]^{-1}(\Lambda\hat{\theta} - c)$$

is distributed as χ^2, but again there is essentially no discussion of the distribution under the non-null hypothesis. The relationship of test criteria in the linear hypothesis to minimum sums of squares under the null and alternate hypotheses is not given. The first chapter then is a very abbreviated discussion of the general linear hypothesis, but not really suitable for the student.

Chapter II, entitled General Structure of Analyis of Designs, gives a general treatment of the two-way and three-way classification (no interaction, uncorrelated errors with expectation zero, and the same variance) in terms of matrices, and the presentation is pedagogically useful. It also deals with a particular case of partial confounding, where treatments are arranged in replicates with different confounding.

Chapter III describes the standard designs, randomized block, Latin square, Graeco-Latin square, crossover, balanced incomplete block designs, Youden squares, lattice, and PBIB designs, all with errors which have expectation zero, are uncorrelated, and have the same variance. The formula for estimating what