DESIGN OF EXPERIMENTS

- ❖ INTRODUCTION
- ❖ HISTORY &APPLICATIONS
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INTRODUCTION

- Design of Experiment (DOE) is a powerful statistical technique for improving product/process designs and solving production problems.
- Design of Experiments has a rich history connected to agriculture, eng ineering and manufacturing.
- DOE makes controlled changes to input variables in order to gain maximum amounts of information on cause and effect relationships with a minimum sample size.
- Design of Experiments (DOE) is also referred to as Designed Experiments or Experimental Design.

Why DOE

- Reduce time to design/develop new products & processes
- Improve performance of existing processes
- Improve reliability and performance of products
- Achieve product & process robustness
- Perform evaluation of materials, design alternatives and system tolerances

HISTORY & APPLICATIONS

- Between the years 1918 and 1940, R. A. Fisher & his co-workers applied DOE to the field of agriculture. It had a profound impact on agricultural science, Factorial designs and ANOVA.
- The first industrial era (1951 – late 1970s), Box & Wilson used DOE in the chemical & process industries.
- The second industrial era (late 1970s – 1990), Many companies initiated quality improvements using DOE.

AIM & DEFINITION

- **AIM**

The main aim of the design of experiments 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.

- **DEFINITION**

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 may be well defined.

DESIGN OF EXPERIMENTS

- MAJOR DESIGNS
- BASIC PRINCIPLES
- ANOVA

MAJOR DESIGNS

The major designs are

- Completely Randomized Design (CRD)
- Randomized Block Design (RBD)
- Latin Square Design (LSD)
- 2^2 Factorial Design

BASIC PRINCIPLES

Design of experiments is a systematic method to determine the relationship between factors affecting a process and the output of that process.

The Basic principles of experimental designs are

- Randomization
- Replication
- Local control (error control)

ANOVA

In DOE, the method of Analysis of Variance (ANOVA) is used to find the cause-and-effect relationships between the factors.

- **ANALYSIS OF VARIANCE (ANOVA):**

Analysis of Variance (ANOVA) is a technique that will enable us to test for the significance of the difference among more than two sample means which is used to test the homogeneity of several means.

ASSUMPTIONS IN ANOVA

- Each sample is taken as a random sample.
- Each sample is independent of the other sample.
- Each of the sample is drawn from a normal population.
- The variances for the population from which samples have been drawn are equal.
- The effect of various components and interactions are additive.

USES OF ANOVA

Analysis of variance is useful for determining

- which of various training methods produces the fastest learning record
- whether the effects of some fertilizers on the yields are significantly different
- whether the mean qualities of outputs of various machines differ significantly

DESIGN OF EXPERIMENTS

- One-way classification
- Two-way classification
- Three-way classification

ONE-WAY CLASSIFICATION

In one-way classification, the data is classified according to one factor or criteria.

COMPLETELY RANDOMIZED DESIGN (CRD):

The completely randomized design is the simplest of all designs based on the principles of randomization and replication. In this design, treatments are allotted randomly to the entire experimental units with replication.

ADVANTAGES OF CRD

- It is easy to layout the design.
- It allows complete flexibility. Any number of factor classes and replications may be used.
- It is usually suited only for small number of treatments.
- It provides the maximum number of degrees of freedom for the estimation of the error variance, which increases the sensitivity or the precision of the experiment.

TWO-WAY CLASSIFICATION

In two-way classification, the data is classified according to two factor or criteria

- **RANDOMIZED BLOCK DESIGN (RBD):**

In RBD, entire experimental unit, which is heterogeneous is divided into homogeneous units known as blocks. In each block, treatments are distributed randomly and this is repeated for all blocks.

ADVANTAGES OF RBD

- The design of RBD is more efficient than CRD because of reduction of experimental error.
- In RBD, no restrictions are placed on number of treatments or replications.
- Statistical analysis is simple and rapid.

COMPARISON OF CRD & RBD

- Both CRD and RBD are used to eliminate the influence of only one extraneous variable; however the ANOVA technique employed in CRD and RBD are one way classification and two way classification respectively.
- In CRD, there are k independent groups of samples and in each group, there are m replications. In RBD, there are k treatments and m blocks, so that each treatment occurs only once in each block.

THREE-WAY CLASSIFICATION

LATIN SQUARE DESIGN:

- A design in which each treatment appears once and only once in each row and column is called Latin Square Design (LSD). In this design, there have to be as many replications as there are treatments, that is, if there are *n* treatments, then there will be *n* repetitions. Hence the given experimental unit is divided into n^2 units, with *n* rows and *n* columns. The data is classified according to different criteria that is according to columns, rows and varieties and arranged in a square known as Latin Square.

ADVANTAGES OF LSD

- LSD controls more of the variation than RBD.
- In the case of field experimentation, if the fertility varies in 2 directions then LSD can be used than RBD.
- More than one factor can be investigated simultaneously.

COMPARISON OF RBD & LSD

- RBD is used to control the effects of only one extraneous variable. But LSD can be used to control the effects of two extraneous variables.
- LSD can be applied only on a square field while RBD can be applied to square or rectangular fields.
- RBD is suitable for large number of treatments whereas LSD is suitable for only limited number of treatments
- The number of replications of each treatment is equal to the number of treatments in LSD. However, there is no restrictions on treatments and replications in RBD.

THANK YOU