

machine (generator and motor), EMF and torque equations, excitation of DC generator and their characteristics, DC motor characteristics, starting of shunt and series motor, starters, speed control methods-field and armature control.

Three phase induction motor: construction, operation, types, concept of slip; slip speed and slip frequency, torque equation, torque-speed and torque-slip characteristics, maximum torque for starting and running condition. phasor diagram, starting and speed control methods; Single phase induction motor: principle of operation, double field revolving theory, equivalent circuit, characteristics, methods of starting, phase split, shaded pole motors, performance characteristics.

### Practical

To study different parts of DC/AC machines; To perform open circuit test on a single phase transformer and determine its iron loss as well as open circuit parameters; To perform short circuit test on a single phase transformer and hence find copper loss, equivalent circuit parameters, voltage regulation and efficiency; To study how to start the D.C motor using 3-point Starter; To start and run the D.C. motor (shunt, series and compound); To control the speed of DC shunt motor using flux control method; To control the speed of DC shunt motor using armature voltage control method; To conduct brake test on DC shunt motor and to determine its performance curves; To obtain the load characteristics of DC shunt motor and draw its characteristics; To start and run the 3-phase induction motor using star-delta starter and to find different voltage and current under star and delta connection; To perform no-load test on 3-phase induction motor and to determine its no-load losses; To perform blocked-rotor tests on 3-phase induction motor to obtain the equivalent circuit parameters and to draw the circle diagram; To perform no load on 1-phase induction motor to determine its no-load losses; To perform blocked-rotor test on 1-phase induction motor and to determine the parameters of equivalent circuit on the basis of double revolving field theory; To perform load-test on 1-phase induction motor and plot torque-speed characteristic.

### Suggested Readings

1. Anwani, M. L. 1997. *Basic Electrical Engineering*. Dhanpat Rai & Co. (P) LTD. New Delhi.
2. Boylestad, Robert, L. and Louis, N. 2015. *Electronic Devices and Circuit*. 11<sup>th</sup> edn. Pearson India.
3. Shaney, A. K. 1997. *Measurement of Electrical and Electronic Instrumentation*. Khanna Publications
4. Thareja, B. L. and Theraja, A. K. 2005. *A Textbook of Electrical Technology*. Vol. I. S. Chand & Company LTD., New Delhi.
5. Theraja, B. L. and Theraja, A. K. 2005. *A Textbook of Electrical Technology*. Vol. II. S. Chand & Company LTD., New Delhi.

### Agricultural Statistics and Data Analysis

2 (1+1)

#### Objective

To make the students acquainted with important statistical data analysis tools and application of these for research in agricultural engineering

## Theory

Introduction to statistics: Definition, advantages and limitations; Data- types of data, quantitative and qualitative; variable - discrete and continuous; Frequency distribution table: construction of frequency distribution table (inclusive and exclusive)- number of classes, length of class, tally marks, frequency, class midpoint, cumulative frequencies, frequency curves, graphs and charts.

Measures of central tendency: Definition, characteristics of ideal average, different measures; arithmetic mean, median, mode, geometric mean and harmonic mean for grouped and ungrouped data, merits and demerits; Measures of dispersion: definition, different measures (absolute and relative); range, quartile deviation, mean deviation, standard deviation (SD), variance and coefficient of variation.

Probability: Definition and concept of probability; Random variable: concept of random variable and expectation; Simple linear correlation: concept, definition, types and its properties; Simple linear regression: concept, definition and its properties; Normal distribution: definition, density function, curve, properties, standard normal distribution (SND), properties including area under the curve (without proof); Binomial distribution: definition, density function and properties; Poisson distribution: definition, density function and properties; Introduction to sampling: definition of statistical population, sample, random sampling, parameter, statistic, sampling distribution, concept of standard error of mean.

Testing of hypothesis – hypothesis, null hypothesis, types of hypothesis, level of significance, degrees of freedom – statistical errors; Large Sample test (Z-test), small sample t-test (one tailed, two tailed and paired tests); Testing of significance through variance (F-test), Chi-square test: goodness of fit and testing of independence of attributes ( $2 \times 2$  contingency table).

## Practical

Construction of frequency distribution tables and frequency curves; Computation of arithmetic mean, median and mode for un-grouped and grouped data; Computation of harmonic and geometric mean; Computation of standard deviation (SD); Variance and coefficient of variation for un-grouped and grouped data; Computation of skewness, kurtosis; Standard normal distribution test for single sample mean (population SD known and unknown); SND test for two samples means (population SD known and unknown); Computation of binomial distribution; Computation of Poisson distribution; Calculation of correlation coefficient and its testing; Calculation of regression coefficient, regression line; Student's t-test for single sample mean; t-test for two samples means; Paired t test; F- test for equality for two sample variance test; Computation of Chi-square test: goodness of fit and testing of independence of attributes ( $2 \times 2$  contingency table) and  $m \times n$ .

## Suggested Readings

1. Agrawal, B. L. 1991. *Basic Statistics*. Wiley Eastern Ltd. New Age International Ltd.
2. Chandel, S. R. S. 1999. *A Handbook of Agricultural Statistics*. Achal Prakasan Mandir, Kanpur
3. Gupta, S. C. and Kapoor, V. K. 1970. *Fundamentals of Mathematical Statistics*. Sultan Chand & Sons.
4. Gupta, S. C. and Kapoor, V. K. 2019. *Fundamental Applied Statistics*. Sultan Chand & Sons.
5. Nageswara Rao, G. 2007. *Statistics for Agricultural Sciences*. BS Publications.
6. Rangaswamy, R. 2018. *A Text Book of Agricultural Statistics*. New Age Int. publications Ltd.