# POWER QUALITY

**Course Code:13EE2214** **L P C**
**4 0 3**

**Pre requisites:** Basic knowledge in Electrical Networks, Electrical Machines, Power Electronics.

**Course Educational Objectives:**

To study and understand the definitions, various power quality problems and their mitigation and measuring techniques.

**Course Outcomes:** After completion of the course, the student should be able to know

1. Basic concepts of power quality issues.
2. Voltage and current during the fault period of a given power system.
3. Sags and phase angle jumps in different types of faults.
4. Various equipment behavior with voltage sags.
5. Various interfacing devices between system and equipment to mitigate the sags and interruptions

## UNIT-I: INTRODUCTION AND EMC STANDARDS

Introduction of the Power Quality (PQ) problem, Terms used in PQ: Voltage Sag, Swell, Surges, Harmonics, over voltages, spikes, Voltage fluctuations, Transients, Interruption, overview of power quality phenomenon, purpose of standardization, IEC electromagnetic compatibility standards, European voltage characteristics.

## UNIT-II LONG INTERRUPTIONS AND SHORT INTERRUPTIONS

Interruptions – Definition – Difference between failures, outage, Interruptions – causes of Long Interruptions – Origin of Interruptions – Limits for the Interruption frequency – Limits for the interruption duration – costs of Interruption – Overview of Reliability evaluation to power quality, comparison of observations and reliability evaluation.

Short interruptions – definition, origin of short interruptions, basic principle, fuse saving, voltage magnitude events due to re-closing, voltage during the interruption, monitoring of short interruptions, difference between medium and low voltage systems. Multiple events, single phase tripping – voltage and current during fault period, voltage



and current at post fault period, stochastic prediction of short interruptions.

**UNIT-III**

**VOLTAGE SAG – CHARACTERIZATION – SINGLE PHASE AND THREE PHASES:**

Voltage sag – definition, causes of voltage sag, voltage sag magnitude and monitoring, theoretical calculation of voltage sag magnitude, voltage sag calculation in non-radial systems, meshed systems and voltage sag duration.

Three phase faults, phase angle jumps, magnitude and phase angle jumps for three phase unbalanced sags, load influence on voltage sags

**UNIT-IV**

**PQ CONSIDERATIONS IN INDUSTRIAL POWER SYSTEMS:**

Voltage sag – equipment behavior of Power electronic loads, induction motors, synchronous motors, computers, consumer electronics, adjustable speed AC drives and its operation. Mitigation methods of AC Drives, adjustable speed DC drives and its operation, mitigation methods of DC drives.

**UNIT-V**

**MITIGATION OF INTERRUPTIONS AND VOLTAGE SAGS**

Overview of mitigation methods – from fault to trip, reducing the number of faults, reducing the fault clearing time, changing the power system, installing mitigation equipment, improving equipment immunity, different events and mitigation methods. System equipment interface – voltage source converter, series voltage controller, shunt controller, combined shunt and series controller.

**TEXT BOOKS:**

1. Math H J. Bollen, "*Understanding Power Quality Problems: Voltage Sags and Interruptions*", 1st Indian edition, IEEE Press,2001.(All units)
2. C.Sankaran, "*Power Quality*", First Indian reprint, CRC press, 2009 (Part of Unit-I).

**REFERENCES:**


1. Roger Dugan, Surya Santoso, Mark F. Mc Granaghan, H. Beaty, "*Electrical Power Systems Quality*", McGraw-Hill Professional Publishing, Second Edition, November 2002.
2. J. Arrillaga, N. R. Watson, S. Chen, "*Power System Quality Assessment*", John Wiley & Sons, 2000.