EEPE3011 ELECTRICAL POWER QUALITY (3-0-0)

Course Learning Objectives: This course will enable students to:

1. Explain the fundamental concepts, terminology, and major power quality issues (sags, swells, interruptions, harmonics, transients) and interpret relevant national and international power quality standards (e.g., IEEE 519, IEEE 1159, IEC 61000).
2. Analyze the generation, characteristics, and effects of harmonics in power systems due to non-linear loads and compute key distortion indices such as Total Harmonic Distortion (THD) and Individual Harmonic Distortion (IHD).
3. Evaluate various harmonic mitigation techniques, comparing the operation, advantages, and limitations of passive filters with active and hybrid power filters.
4. Identify the causes and effects of voltage quality issues (sags, swells, interruptions, fluctuations, flicker) and propose appropriate measurement and mitigation strategies.
5. Compare the roles, operating principles, and control strategies of different Custom Power Devices (DSTATCOM, DVR, UPQC) in mitigating various power quality problems in distribution networks.

Module I (4 Hours)

Introduction to Power Quality: Terms and definitions, power quality issues in modern power systems-voltage sags, swells, interruptions, harmonics, and transients.
Power Quality Standards: Overview of national and international standards (e.g., IEEE 519, IEEE 1159, IEC 61000) for power quality monitoring and mitigation.
Causes and Effects of Power Quality Problems, Power Quality Monitoring.

Module II (8 Hours)

Harmonics Fundamentals: Generation of harmonics due to non-linear loads (e.g., rectifiers, inverters, adjustable speed drives), Characteristics and effects, principles of harmonic distortion; total harmonic distortion (THD) and individual harmonic distortion (IHD).
Passive Harmonic Mitigation: Design and application of passive filters (e.g., shunt, series, and double-tuned filters) for harmonic suppression. Advantages and limitations of passive filters.
Active Harmonic Mitigation: Introduction to active power filters (APFs) and hybrid filters. Operating principles of shunt active power filters and series active power filters.

Module III (4 Hours)

Voltage Sags and Swells: Causes, characteristics, and effects of voltage sags and swells. Methods for measurement and analysis, including voltage tolerance curves. Differences between short and long interruptions; impact on sensitive equipment; and mitigation strategies.
Voltage Fluctuations and Flicker: Causes of voltage fluctuations, flicker measurement and standards; mitigation techniques.

Module IV (10 Hours)

Introduction to Custom Power Devices: DSTATCOM, DVR, and UPQC: Their Roles in Improving Power Quality in Distribution Networks.
DSTATCOM (Distribution Static Compensator): Operating principles, control strategies, and applications for reactive power compensation, load balancing, and harmonic mitigation 9.
DVR (Dynamic Voltage Restorer): Detailed study of DVR for voltage sag mitigation; design considerations and control techniques.
UPQC (Unified Power Quality Conditioner): Integration of series and shunt compensators; comprehensive power quality improvement using UPQC

Module V (4 Hours)
Distributed Generation and Power Quality: Power Quality issues, operating conflicts, DG on Distribution Networks, interconnection standards, wiring and grounding.

Course Outcomes (CO): On completion of this course, students are able to:

CO1. Explain the fundamental concepts, terminology, and major power quality issues (sags, swells, interruptions, harmonics, transients) and interpret the relevant national and international power quality standards (e.g., IEEE 519, IEEE 1159, IEC 61000).

CO2. Analyze the generation, characteristics, and effects of harmonics in power systems due to non-linear loads and calculate key distortion indices like Total Harmonic Distortion (THD) and Individual Harmonic Distortion (IHD).

CO3. Evaluate different harmonic mitigation techniques, contrasting the operation, advantages, and limitations of passive filters with active and hybrid power filters.

CO4. Identify the causes and effects of voltage quality issues (sags, swells, interruptions, fluctuations, flicker) and propose appropriate measurement and mitigation strategies for them.

CO5. Compare the roles, operating principles, and control strategies of different Custom Power Devices (DSTATCOM, DVR, UPQC) in mitigating various power quality problems in distribution networks.

Text Book(s):

1. Electric Power Systems Quality, by Roger C. Dugan, Mark F. McGranaghan, Surya Santoso, and H. Wayne Beaty , 2nd Edition, (McGraw-Hill, 2006).
2. Power Quality Enhancement Using Custom Power Devices, by Arindam Ghosh and Gerard Ledwich (Kluwer Academic Publishers, 2002).
3. Power Quality: Problems and Mitigation Techniques by Bhim Singh, Ambrish Chandra, and Kamal Al-Haddad (John Wiley & Sons, 2015).

Reference Book(s):

1. Power Quality in Power Distribution Systems: Concepts and Applications, by Mahesh Kumar Mishra, CRC press, 2024.
2. Power Quality, by C. Sankaran, CRC press, 2002.
3. Understanding Power Quality Problems: Voltage Sags and Interruptions, by M. H. J. Bollen, IEEE Press Series on Power Engineering, New York, 2000.
4. Power System Quality Assessment, by J. Arrilaga, N R Wattson and S. Chen, John Wiley & Sons, 2000.
5. Electrical Power Quality, by J. B. Dixit and Amit Yadav, University Science Press, New Delhi, 2010.
6. Electric Power Quality, by S. Chattopadhyay, M. Mitra and S.Sengupta, , Springer Verlag, London, 2011