Approved in 44th BoA Meeting (24-11-2021)

Course number : EE 537
Course Name : Power Quality Problems and Mitigation Techniques in Microgrids
Credit Distribution : 3-0-0-3
Intended for : UG/PG
Prerequisite : Power System (EE303) & Power Electronics (EE 309)
Mutual Exclusion : NA

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1. Preamble:

The clusters of microgrids are the main building blocks of the smart grids, and these are the integral part of the modern power system. Due to the increased use of power electronic converters in domestic, commercial, and industrial & transportation sectors, the quality of power in distribution networks is deteriorating at an alarming rate. This is causing a number of problems to ICT industry, data centres and digital transformation. Moreover, these problems are aggravated by the direct injection of intermittent power from renewable energy sources. This course will cover the common power quality problems in the microgrids, techniques for enhancement of power quality, EV charging Infrastructure, associated power quality issues and their mitigation schemes.

2. Course Modules with quantitative lecture hours:

Unit 1: Power Quality Issues: Harmonics, frequency deviations, voltage fluctuations, voltage dips, swells, and interruptions. Power tetrahedron, power factor, and other figures of merit under balanced, unbalanced and nonsinusoidal conditions, power quality standards. **(8 Hours)**

Unit 2: Power Quality Enhancement: Generation of reference currents/voltages- natural frame of reference (abc), stationary frame of reference (αβ0) and synchronously reference frame (dq0) and symmetrical components frame reference (+-0). Advanced control architectures for hybrid AC–DC Microgrid-decentralized and hierarchical control- droop, primary, secondary and tertiary controls. Cooperative control for power quality enhancement in microgrids-active power Injection, reactive power-sharing, harmonic current sharing and voltage regulation via smart loads. **(10 Hours)**

Unit 3: Autonomous Control of Distributed Energy Resources in Microgrids: power sharing schemes for voltage unbalance and harmonics compensation in an Islanded microgrid- Power droop control, virtual impedance loop, local unbalance and harmonics compensation schemes. Effect of faults, overloading and loss of generation on power quality **(8 Hours)**

Unit 4: Power Quality Problems associated with Electric Vehicle Charging Infrastructure: Various configurations of chargers-contact and contact-less chargers, wired AC, DC

charging-on-board slow, fast charging, off-board fast, rapid charging. Wireless chargers-inductive, capacitive and hybrid charging topologies **(10 Hours)**

Unit 5: Recent Trends and Case Studies: power quality enhancement in AC-DC hybrid microgrids under grid interactive mode, autonomous control of distributed energy resources, power quality problems and their mitigation techniques for various EV charger topologies. **(6 Hours)**

Laboratory/practical/tutorial Modules:

3. Text books:

1. Arindam Ghosh and Gerard Ledwich, "Power quality enhancement using custom power devices", Springer Science & Business Media, 2012.
2. Hirofumi Akagi, Edson Hirokazu Watanabe and Mauricio Aredes, "Instantaneous power theory and applications to power conditioning", John Wiley & Sons, 2017.

4. References:

1. Narain G Hingorani and Laszlo Gyugyi, "Understanding FACTS: concepts and technology of flexible AC transmission systems," Wiley-IEEE press, 2000.
2. Selected papers, standards and reports

5. Similarity with the existing courses: Nil

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.				

6. Justification of new course proposal if cumulative similarity content is >30%: Nil