# POWER QUALITY

**PROF. BHIM SINGH**
Department of Electrical Engineering
IIT Delhi

**PRE-REQUISITES :** Circuit and Networks, Basic Electrical Engineering, Power Electronics, Power System, and Linear Control System

**INTENDED AUDIENCE :** Primarily the graduate students working in the area of energy economics and energy policy domain. This course will also be useful for general audience

**INDUSTRIES APPLICABLE TO :** ABB Group, Schneider Electric, General Electric (GE), Siemens, Captech, Electrical India

## COURSE OUTLINE :

This course is intended to provide tools to classify, quantify, and analyze the power quality problems and to provide practical engineering solutions to mitigate these problems. The objectives of this course are as follows.

- To understand the various power quality issues.
- To understand the concept of power and power factor in single-phase and three-phase systems supplying nonlinear loads.
- To understand the conventional compensation techniques used for power factor correction and load voltage regulation.
- To understand the active compensation techniques used for reactive power compensation, load balancing, power factor correction, and load voltage regulation.
- To understand the active filter techniques used for harmonics elimination.
- To understand the power quality improvement in SMPS, drive systems,and renewable energy systems.

## ABOUT INSTRUCTOR :

Prof. Bhim Singh has received his B.E. (Electrical) from the University of Roorkee, India, in 1977 and his M.Tech. (Power Apparatus & Systems) and Ph.D. from the Indian Institute of Technology Delhi, India, in 1979 and 1983, respectively. In 1983, he joined the Department of Electrical Engineering, University of Roorkee (Now IIT Roorkee), as a Lecturer. He became a Reader there in 1988. In December 1990, he joined the Department of Electrical Engineering, IIT Delhi, India, as an Assistant Professor, where he has become an Associate Professor in 1994 and a Professor in 1997. He has been ABB Chair Professor from September 2007 to September 2012. He has also been CEA Chair Professor from October 2012 to September 2017. He has been Head of the Department of Electrical Engineering at IIT Delhi from July 2014 to August 2016. He has been the Dean, Academics at IIT Delhi from august 2016 to August 2019. He is JC Bose Fellow of DST, Government of India since December 2015. Prof. Singh is the Chairman of BOG, Maulana Azad National Institute of Technology, Bhopal, since 3rd July 2018 for 3 Years and Nonofficial Independent Director, NTPC Limited, since 17th July 2018 for 3 Years. He is CEA Chair Professor since January 2019. Prof. Singh is also member of Governing Council of Central Power Research Institute. Prof. Singh has guided 95 Ph.D. dissertations, and 168 M.E./M.Tech./M.S.(R) theses. He has been filed 69 patents. He has executed more than eighty sponsored and consultancy projects. He has co-authored a text book on power quality: Power Quality Problems and Mitigation Techniques published by John Wiley & Sons Ltd. 2015. In his academic career, he published 961 journal papers in reputed international and national journals and 1382 conference papers in various international and national conferences. His areas of interest include grid-interfaced solar photovoltaic system, solar water pumping system, solar lighting system, renewable energy source based microgrid, electric vehicle charging infrastructure, designing of the high efficient motor for the electric vehicle, designing of the high power charger for the electric vehicle, power quality monitoring and mitigation improved power quality AC-DC converters, power electronics, electrical machines, drives, flexible alternating transmission systems, and high voltage direct current systems. Prof. Singh is a Fellow of the Indian National Academy of Engineering (FNAE), The Indian National Science Academy (FNA), The National Academy of Science, India (FNASc), The Indian Academy of Sciences, India (FASc), The World Academy of Sciences (FTWAS), Institute of Electrical and Electronics Engineers (FIEEE), the Institute of Engineering and Technology (FIET), Institution of Engineers (India) (FIE), and Institution of Electronics and Telecommunication Engineers (FIETE) and a Life Member of the Indian Society for Technical Education (ISTE), System Society of India (SSI), and National Institution of Quality and Reliability (NIQR).

He has received Khosla Research Prize of University of Roorkee in the year 1991. He is recipient of JC Bose and Bimal K Bose awards of The Institution of Electronics and Telecommunication Engineers (IETE) for his contribution in the field of Power Electronics. He is also a recipient of Maharashtra State National Award of Indian Society for Technical Education (ISTE) in recognition of his outstanding research work in the area of Power Quality. He has received PES Delhi Chapter Outstanding Engineer Award for the year 2006. Professor Singh has received Khosla National Research Award of IIT Roorkee in the year 2013. He is a recipient of Shri Om Prakash Bhasin Award-2014 in the field of Engineering including Energy & Aerospace. Professor Singh has received IEEE PES Nari Hingorani Custom Power Award-2017. He is also a recipient of "Faculty Research Award as a Most Outstanding Researcher" in the field of Engineering-2018 of Careers 360, India. He has received Faculty Lifetime Research Award-2018 for overall research contribution at IIT Delhi. He is recipient IEEE-IAS outstanding educator/mentor award 2020. Prof. Singh is also the recipient of INAE outstanding teaching award 2020 and Eminent Engineer Award-2020 from Institution of Engineers (India). Prof. Bhim Singh is the recipient of the first International Solar Alliance (ISA)- Haryana Kalpana Chawla Solar Award for working towards developing solutions in the Solar Energy Sector to help create a sustainable and low-carbon world for generations to come. He has been very active in professional societies such as the Institute of Electrical and Electronics Engineers (IEEE). He has been the Chairman of IEEE PES-IAS Delhi Joint Chapter for the last four years and during this period this chapter won twice the Outstanding Chapter Award, High-Performance Chapter Award every year, and one of best-performing chapter awards of last decade. He has been founder Chairman of IEEE PELS-IES Delhi Joint Chapter and its Chairman since 2006. He is a Distinguished Lecturer (DL) of IEEE Power and Energy Society under the Distinguished Lecture of Program (DLP) of IEEE since the year 2002. He has been the General Chair of the 2006 IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES'2006), General Co-Chair of the 2010 IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES'2010), General Co-Chair of the 2015 IEEE International Conference (INDICON'2015), General Co-Chair of 2016 IEEE International Conference (ICPS'2016) held in New Delhi, General Co-Chair of 2017 National Power Electronics Conference (NPEC) held in Pune. He has been as "Patron" of the IEEE 9th Power India International Conference (PIICON-2020), IEEE International Conference on Computing, Power and Communication Technologies (GUCON-2020), IEEE International Conference on Computing, Communication and Automation (ICCCA-2020), IEEE Indian Council International Conference (IEEE- INDICON 2020). He has been the "Member of Technical Advisory Committee" of the IEEE International conference on Power Electronics, Smart Grid and Renewable Energy (PESGRE 2020), IEEE International Conference on Electrical and Electronics Engineering (ICE3-2020), IEEE Uttar Pradesh Section International Conference on Electrical, Electronics and Computer Engineering (UPCON 2020), (4) National Power Systems Conference (NPSC 2020).

## COURSE PLAN:

**Week 1 :** Power quality: An Introduction
**Week 2 :** Power quality standards and monitoring
**Week 3 :** Passive Shunt and Series Compensation
**Week 4 :** Active Shunt Compensation: DSTATCOM
**Week 5 :** Active Series Compensation: DVR
**Week 6 :** Unified Power Quality Compensators
**Week 7 :** Loads That Cause Power Quality Problems
**Week 8 :** Passive Power Filters
**Week 9 :** Shunt Active Power Filters
**Week 10:** Series Active Power Filters
**Week 11:** Hybrid Active Power Filters
**Week 12:** AC-DC Converters That Cause Power Quality Problems; Improved Power Quality Converters: AC-DC Converters; Improved Power Quality Converters; Power quality improvement in electrical system applications