

GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: Power Electronics and Electrical Drives (45)
SUBJECT NAME: Static VAR Controllers and Harmonic Filtering
SUBJECT CODE: 3714511
M.E. 1st SEMESTER

Type of course: Engineering Science (ELECTRICAL)

Prerequisite: Power Electronics, Power Quality

Rationale: In distribution network, power quality problems have increased due to introduction of loads demanding high reactive power and harmonics. These issues have led to increased losses and non-optimal utilization of systems. Interfacing of custom power devices have resulted into reduced harmonic distortions as well as high power factor operation. The subject aims at introducing custom power solutions to mitigate power quality issues in distribution systems.

Teaching and Examination Scheme :

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE(E)	PA (M)	PA (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Introduction Fundamentals of Load Compensation, Steady-State Reactive Power Control in Electric Transmission Systems, Reactive Power Compensation and Dynamic Performance of Transmission Systems.	4	10%
2	Custom Power Devices: An Introduction Utility Customer Interface, Introduction to Customer Power Devices such as DSTATCOM, DVR and UPQC	4	10%
3	Load Compensation using DSTATCOM Compensating single-phase loads, ideal three-phase shunt compensator structure, Generating reference currents using instantaneous pq theory, Generating reference currents using Instantaneous symmetrical components, general algorithm for generating reference, Currents for balanced and unbalanced source voltages	8	20%
4	Realization and Control of DSTATCOM DSTATCOM structure, control of DSTATCOM connected to a stiff source, DSTATCOM connected to weak supply point, DSTATCOM current control through phasors, DSTATCOM in voltage control mode	6	10%
5	Shunt Active Power Filter General Description of Shunt Active Filter, Three Phase Three Wire Shunt Active Filters – Constant Power Compensation, Sinusoidal Current Control, Fryze current compensation and Synchronous Reference Frame theory, Active Power Filter for Harmonic Damping, Current Control methods, Three Phase Four Wire Shunt Active Filter – converter	12	30%

	topologies, dynamic current controller, performance analysis, Shunt selective harmonic compensation		
6	Series and Hybrid Active Filters Principle of Operation of series active filter, classification of series active filter, Control of series active filter, Analysis and Design of series active filter, Combined series active and shunt passive filter – Compensation Principle, Filtering characteristics, Control circuit, Design of filters to suppress switching ripple	8	20%

Reference Books:

1. A. Ghosh, G. Ledwich, 'Power Quality Enhancement Using Custom Power Devices', Kluwer Academic Publisher, 2002.
2. H. Akagi, E. H. Watanabe, M. Aredes, 'Instantaneous Power Theory and Applications to Power Conditioning', 2nd Edition, 2017.
3. B. Singh, A. Chandra, K. Al-Haddad, 'Power Quality: Problems and Mitigation Techniques', John Wiley & Sons, 2015.
4. R. S. Vedam, M. S. Sarma, 'Power Quality VAR Compensation in Power Systems', CRC Press, Taylor & Francis Group, 2009.

Course Outcome:

After learning the course, the students should be able to:

1. Understand the role of various custom power devices (Understand)
2. Apply the concept of DSTATCOM for reactive power compensation (Apply)
3. Determine the algorithm for DSTATCOM under different conditions (Apply)
4. Analyze the Shunt Active Filter under different control algorithm and supply system (Analyze)
5. Develop DSTATCOM and Shunt Active Filter for compensation of reactive power and harmonics (Create)
6. Evaluate characteristics of series active filter (Evaluate)

List of Experiments:

1. Determine the compensation requirement of Linear and Non-linear load under different power factor and harmonic condition
2. Simulate reference current of DSTATCOM using instantaneous p-q theory.
3. Design and Simulate DSTATCOM for reactive power compensation at different power factors
4. Evaluate the role of DSTATCOM in Voltage Regulation Mode
5. Design and Simulate Shunt Active Filter for three phase three wire system using constant instantaneous power method.
6. Design and Simulate Shunt Active Filter for three phase three wire system using sinusoidal current control method.
7. Design and Simulate Shunt Active Filter for three phase three wire system using synchronous reference frame method.
8. Design and simulate Shunt Active Filter for three phase four wire system.
9. Design and simulate series active power filter for compensation of current harmonics.

Major Equipment:

1. Power Quality Analyzer
2. True RMS Meter
3. Digital Storage Oscilloscope
4. MATLAB Student Version

List of Open Source Software/learning website:

1. Power Standard Lab – teaching tool
2. <http://nptel.ac.in/courses/108106025/>