4.1 Reactive power requirements in steady state

To make transmission networks operate within desired voltage limits and methods of making up or taking away reactive power is called reactive-power control‖. The AC networks and the devices connected to them create associated time-varying electrical fields related to the applied voltage and as well as magnetic fields dependent on the current flow and they build up these fields store energy that is released when they collapse‖.

- Apart from the energy dissipation in resistive components, all energy-coupling devices (e.g.: motors and generators) operate based on their capacity to store and release energy.
- While the major means of control of reactive power and voltage is via the excitation systems of synchronous generators and devices may be deployed in a transmission network to maintain a good voltage profile in the system.
- The shunt connected devices like shunt capacitors or inductors or synchronous inductors may be fixed or switched (using circuit breaker).
- The **Vernier** or smooth control of reactive power is also possible by varying effective susceptance characteristics by use of power electronic devices. Example: Static Var Compensator (SVC)‖ and a Thyristor Controlled Reactor (TCR).

SOURCES OF REACTIVE POWER:

Most equipment connected to the electricity system will generate or absorb reactive power, but not all can be used economically to control voltage. Principally synchronous generators and specialised compensation equipment are used to set the voltage at particular points in the system, which elsewhere is determined by the reactive power flows.

Synchronous generators:

Synchronous machines can be made to generate or absorb reactive power depending upon the excitation (a form of generator control) applied. The output of synchronous machines is continuously variable over the operating range and automatic voltage regulators can be used to control the output so as to maintain a constant system voltage.

Synchronous compensators:

Certain smaller generators, once run up to speed and synchronised to the system, can be declutched from their turbine and provide reactive power without producing real power. This mode of operation is called Synchronous Compensation.

Capacitive and inductive compensators:

These are devices that can be connected to the system to adjust voltage levels. A capacitive compensator produces an electric field thereby generating reactive power whilst an inductive compensator produces a magnetic field to absorb reactive power. Compensation devices are available as either capacitive or inductive alone or as a hybrid to provide both generation and absorption of reactive power.

Transformers:

Transformers produce magnetic fields and therefore absorb reactive power. The heavier the current loading the higher the absorption.

Consumer Loads:

A typical load bus supplied by a power system is composed of a large number of devices. The composition changes depending on the day, season and weather conditions. The composite characteristics are normally such that a load bus absorbs reactive power. Both active and reactive powers of the composite loads Concepts of Reactive Power Control and Voltage Stability Methods in Power System Network vary due to voltage magnitudes. Loads at low-lagging power factors cause excessive voltage drops in the transmission network. Industrial consumers are charged for reactive power and this convinces them to improve the load power factor.

Underground cables-

They are always loaded below their natural loads, and hence generate reactive power under all operating conditions

Overhead lines-

Depending on the load current either absorb or supply reactive power. At loads below the natural load, the lines produce net reactive power; on the contrary, at loads above natural load lines absorb reactive power.