synchronizing torque, or (ii) rotor oscillations of increasing amplitude due to lack of sufficient damping torque.

In today's practical power systems, small signal stability is largely a problem of insufficient damping of oscillations. The time frame of interest in small-signal stability studies is on the order of 10 to 20 s following a disturbance. The stability of the following types of oscillations is of concern:

Local modes or machine-system modes, associated with the swinging of units at a generating station with respect to the rest of the power system. The term ''local'' is used because the oscillations are localized at one station or a small part of the power system.

Inter area modes, associated with the swinging of many machines in one part of the system against machines in other parts. They are caused by two or more groups of closely coupled machines that are interconnected by weak ties.

Control modes, associated with generating units and other controls. Poorly tuned exciters, speed governors, HVDC converters, and static var compensators are the usual causes of instability of these modes. Torsional modes, associated with the turbine-generator shaft system rotational components. Instability of torsional modes may be caused by interaction with excitation controls, speed governors, HVDC controls, and series-capacitor-compensated lines.

b. Large disturbance rotor angle stability or transient stability, as it is generally alluded to, is worried about the capacity of the force framework to keep up synchronism when exposed to an extreme transient aggravation. The subsequent framework reaction includes enormous trips of generator rotor points and is impacted by the nonlinear force point relationship. Transient dependability relies upon both the underlying working condition of the framework and the seriousness of the unsettling influence. Generally, the unsettling influence modifies the framework with the end goal that the post-aggravation consistent state activity will be unique in relation to that preceding the unsettling influence. Precariousness is as an intermittent float because of inadequate synchronizing force, and is alluded to as first swing dependability. In enormous force frameworks, transient flimsiness may not generally happen as first swing unsteadiness related with a solitary mode; it very well may be because of expanded pinnacle deviation brought about by superposition of a few methods of wavering causing huge trips of rotor point past the primary swing. The time span of interest in transient soundness is normally restricted to 3 to 5 sec after the unsettling influence. It might reach out to 10 sec for exceptionally enormous frameworks with prevailing between region swings. Force frameworks experience a wide assortment of aggravations. It is unrealistic and uneconomical to plan the frameworks to be steady for each conceivable possibility. The plan possibilities are chosen on the premise that they have a sensibly high likelihood of event.

2.3 **Frequency Stability** Frequency stability refers to the capacity of a force framework to keep up consistent recurrence following a serious framework upset bringing about a huge unevenness among age and burden. Recurrence precariousness prompts stumbling of creating units and additionally stacks. For the most part, recurrence soundness issues are related with deficiencies in hardware reactions, helpless coordination of control and assurance gear, or deficient age save.

Over the course of a frequency instability, the trademark seasons of the cycles and dev of special operational requirements of local substations and adjusting the voltage in the distribution transformer at consumer end.

3.3 **ADVANTAGE OF TAP CHANGING TRANSFORMER**

During high system load conditions, network voltages are kept at the highest practical level to minimize reactive power requirements, increase effectiveness of shunt capacitors to compensate for reactive power.

During light load conditions, it is usually required to lower network voltages, avoid under excited operation of generators

3.4 **VOLTAGE CONTROL BY SHUNT REACTORS**

Shunt Reactors are Inductive gadgets regularly given at sending end and getting end of the long EHV and UHV transmission Systems for remunerating the overabundance capacitive VArs in a force framework. Because of the inductive nature of the Shunt Reactor, it is utilized at whatever point there is need for remuneration of capacitive reactance. Force System loads are transcendently inductive in nature and Capacitor banks are utilized to make up for the inductive burdens. During framework light burden conditions, regular voltages increment past the ordinary working levels and such a condition requests extra inductive burdens to keep up framework voltage levels inside the typical reach. For example, a getting end voltage of 400kV, 1000 km long queue the voltage might be just about as high as 800kV. The shunt capacitance of this lines should

3.6 **VOLTAGE CONTROL BY SERIES CAPACITORS**

Series compensation is the method of improving the system voltage by connecting a capacitor in series with the transmission line. In other words, in series compensation, reactive power is inserted in series with the transmission line for improving the impedance of the system. It improves the power transfer capability of the line. It is mostly used in extra and ultra-high voltage lines to reduce the effect of inductive reactance XL between the sending end and receiving end of the line. One of the major drawbacks of series capacitors is that high over-voltages are produced across the capacitor terminals under short circuit conditions. Series capacitors are usually employed for increasing the power transfer capability of the transmission line and not for voltage regulation

3.7 **VOLTAGE CONTROL BY STATIC SHUNT COMPENSATION:**

Static Var Compensators (SVCs) are devices that can quickly and reliably control line voltages. An SVC will regulate and control the voltage to the required set point under normal steady state and thereby provide dynamic, fast response reactive power following system contingencies (e.g. network short circuits, line and generator disconnections). In addition, an SVC can also increase transfer capability, reduce losses, mitigate active power oscillations and prevent overvoltages at loss of load.

The SVC consists of a number of fixed or switched branches, of which at least one branch includes thyristors, and the combination of branches can be varied a lot depending on requirements. An SVC typically includes a combination of at least two of the given items below (e.g., TCR/FC or TCR/TSC/FC):

The induced emf of the synchronous generator (E) depends upon the excitation current (field current). The terminal voltage V of synchronous generators are given by V = E – IX The generators have excitation and automatic voltage regulation systems (AVR). The function of this systems is

To control the load under steady state operating conditions for operating near steady state stability limit

- To regulate voltage under fault conditions (faults in the grid system beyond generator protection zone)
- To enable sharing of reactive power. The reactive power shared by a generator depends upon its excitation level the terminal voltage of the synchronous generator is held within the permissible limits by automatic voltage regulators (AVR) systems

4.3 VOLTAGE CONTROL OF TRANSMISSION SYSTEM USING STATIC VAR COMPENSATOR

Static Var Compensator is fundamentally a shunt associated Static Var Generator whose yield is constrained by changing the worth of capacitive or inductive current. One reason for introducing the Static Var Compensator is to improve the voltage profile and build the framework load capacity. At the point when framework voltage is low it creates the responsive force. At the point when the framework voltage is high it assimilates the responsive force. Static Var Compensator is a thyristor-based regulator that gives quick voltage control.

Vref. Reactance XSL equivalent to the slope of the V-I characteristics is added between the auxiliary node and node of coupling to the system as shown in Fig. 3. The node at the point of common coupling is a PQ node with P = 0 and Q = 0.

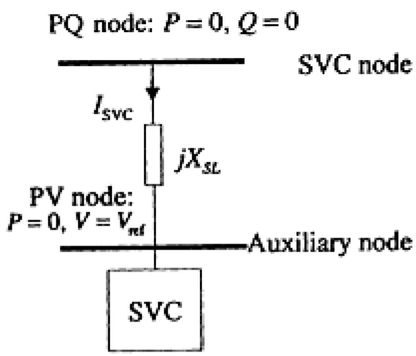

Figure 5 SVC Operating Within Control Range

A static var compensator (SVC) is used to regulate voltage on a 33 kV, 3×50 MVA system. When system voltage is low the SVC generates reactive power (SVC capacitive). When system voltage is high it absorbs reactive power (SVC inductive). The SVC is rated+50 Mvar capacitive and 25 Mvar inductive. The Static Var Compensator block is a Phasor model representing the SVC static and dynamic characteristics at the system fundamental frequency. The SVC is set in voltage regulation mode with a reference voltage Vref = 1.0 pu. The voltage droop is 0.03 p. u, 50MVA, so that the voltage varies from 0.97 p. u to 1.015 p. u when the SVC current goes from fully capacitive to fully inductive. By simulating the SVC V-I characteristic curve is obtained. Then, the actual SVC positive-sequence voltage (V1) and

susceptance (B1) can be measured with system parameters