SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

DEPARTMENT OF EEE

Methods of Voltage Control

Introduction

- A power system is said to be well designed if it gives a good quality(voltage levels within limit) of reliable supply.
- All the equipments on the power system are designed to operate satisfactorily only when the voltage levels on the system correspond to their rated voltages or at the most within say 5%.
- If the voltage variation is more than a prespecified value,the performance of the equipments suffers and life of most of the equipment is sacrificed

Power System Control Methods

- Pf control

  (active power control)

  OR

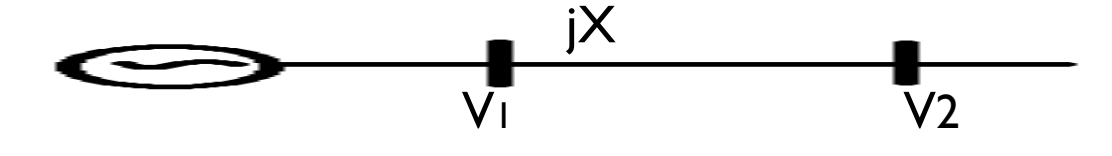
  (frequency control)

- QV control (reactive power control)

  OR

  (voltage control)

Concept of Voltage Control



Load connected to the source through a line

$$V2=(V1-QX/V1)-jPX/V1$$

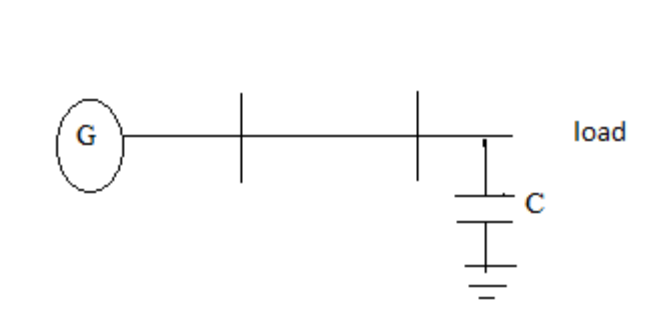
$$V2=(V1-QX/V1)$$

Methods Of Voltage Control

- Shunt capacitor/reactor
- Series capacitor
- Synchronous capacitor
- Tap changing transformer
- Booster transformer

Shunt capacitor/reactor

- Shunt capacitors are used for lagging power factor circuits. Shunt capacitors are disposed along routes to minimize losses and voltage drops. On light loads, when the voltage is high, the capacitor output is large and the voltage tends to rise to excessive levels.
- Shunt reactors are used for leading power factor circuits, as in lightly loaded cables.



Location of Shunt capacitors/reactors

Shunt capacitor are used on the load end of the power system and are applied in a wide range of sizes.

Shunt reactor may be permanently connected to the line to limit the temporary over voltage and switching transients. It may be connected in the EHV bus or to the tertiary windings of adjacent transformer.

Application of Shunt capacitor
1.Distribution system

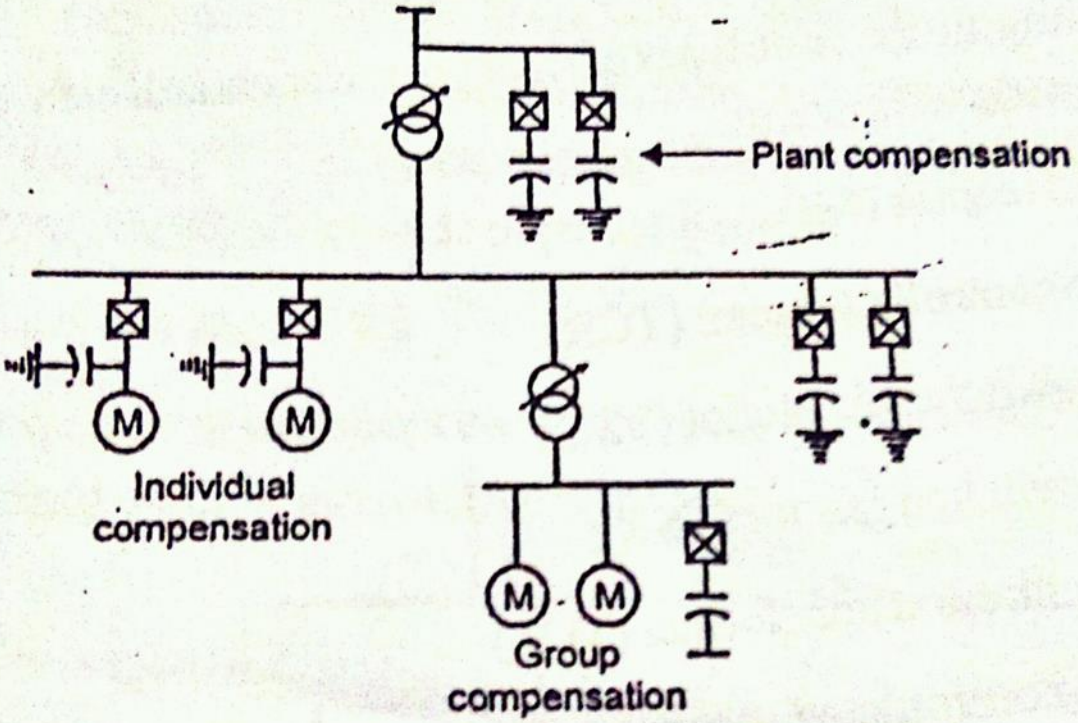
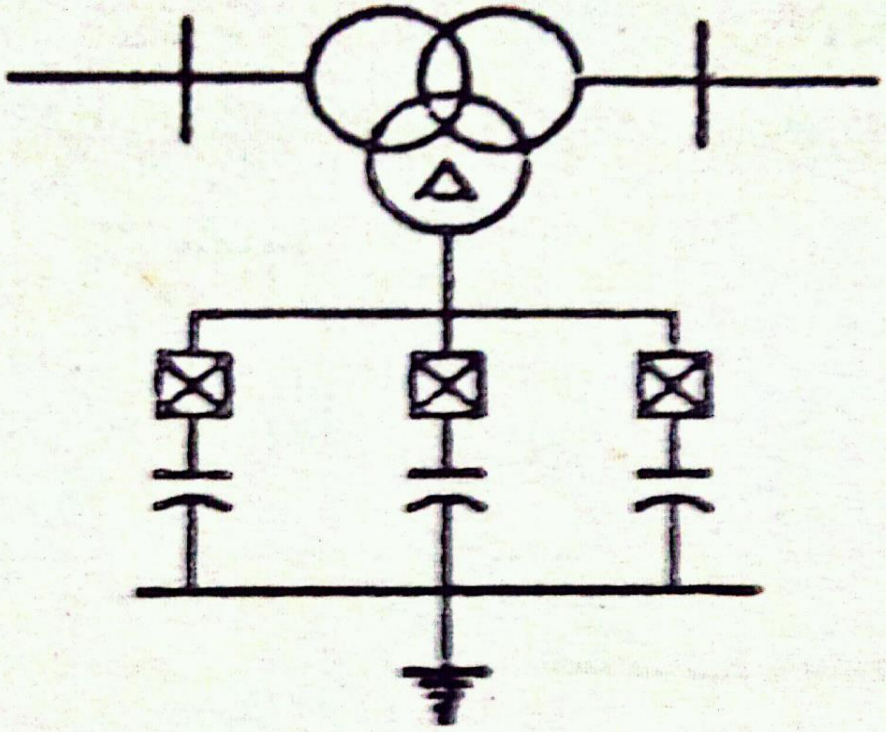


Figure 3.17: Power factor correction in industrial plants

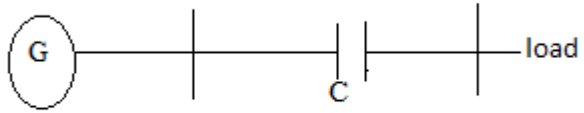
2.Transmission system



(a) Tertiary connected capacitor banks

Series capacitor

- These are connected in series with a line conductor to compensate for the inductive reactance of the line. This reduces the transfer reactance between the busses to which the line is connected, increases maximum power that can be transferred and reduces the reactive power losses.
- Voltage drop is IRCosOr+I(XL-XC)SinOr when the capacitance is very high then series capacitor is very useful. This also improve maximum power transfer capability.



Location of series capacitors

1. Mid point of the line.

2. Line terminals.

3. 1/3 or 1/4 points of the line

Application of series capacitor

1. Distribution feeders
2. EHV Transmission system

Advantages

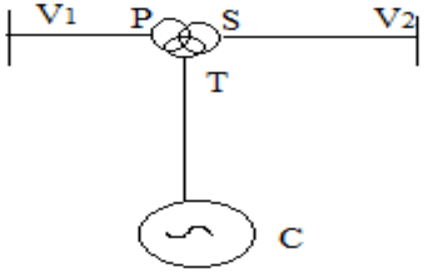
- If the load Var requirement is small, series capacitors are of little use.
- If voltage drop is the limiting factor, series capacitors are effective. Voltage fluctuations due to arc furnaces are also evened out.
- If the total line reactance is high, series capacitors are very effective and stability is improved.

Disadvantages

The major drawback of series capacitors is high overvoltage are produced when a short circuit current flows through the capacitor.

Synchronous capacitor/condenser

- Synchronous motors running without mechanical load can absorb or generate Q depending on the excitation. As the synchronous motor losses are considerable compared to static capacitors, the power factor is not zero. When used with a voltage regulator, the compensator can automatically run overexcited at times of high load and under excited at light loads. The advantage of the synchronous compensator is its flexibility of operation for all load conditions.



Advantages

1. The magnitude of current drawn by the motor can be changed by varying the field excitation.so it gives control of p.f
2. The motor windings should have high thermal stability to short circuit current
3. The faults occurs in the motor is easily removed

Disadvantages

1. It requires more maintenance as well as increases the maintenance cost
2. It produces noise
3. Considerable losses are occur in the motor

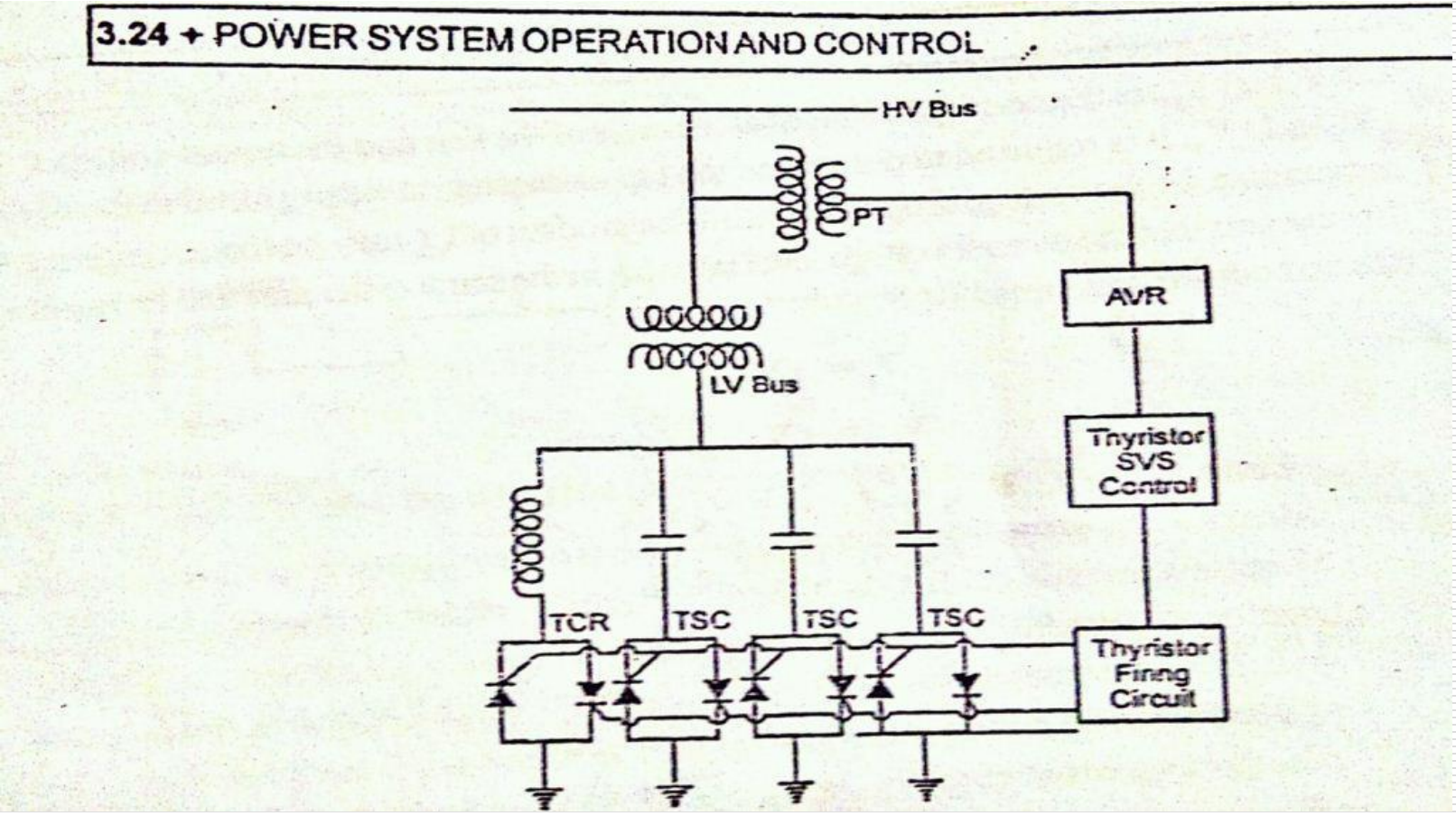
Static Var Compansator System(SVC)

- SVCs are shunt-connected static generators and absorbers whose outputs are varied so as to control specific parameters of the electric power system
- It has no moving or rotating main components.

Types of SVC

1. Thyristor –controlled reactor
2. Thyristor –controlled capacitor
3. Thyristor switched reactor
4. Thyristor –controlled transformer

SVC diagram


3.24 + POWER SYSTEM OPERATION AND CONTROL
HV Bus
PT
AVR
LV Bus
Thyristor SVS Control
TCR
TSC
TSC
TSC
Thyristor Firing Circuit

Characteristic of ideal SVS

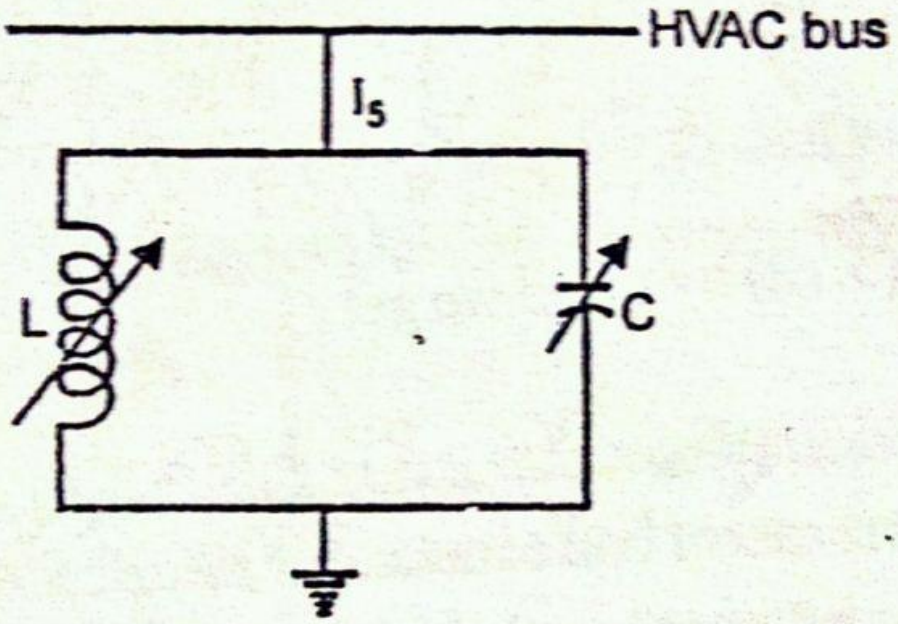


Figure 3.20: Idealized static var system

Characteristic of realistic SVS

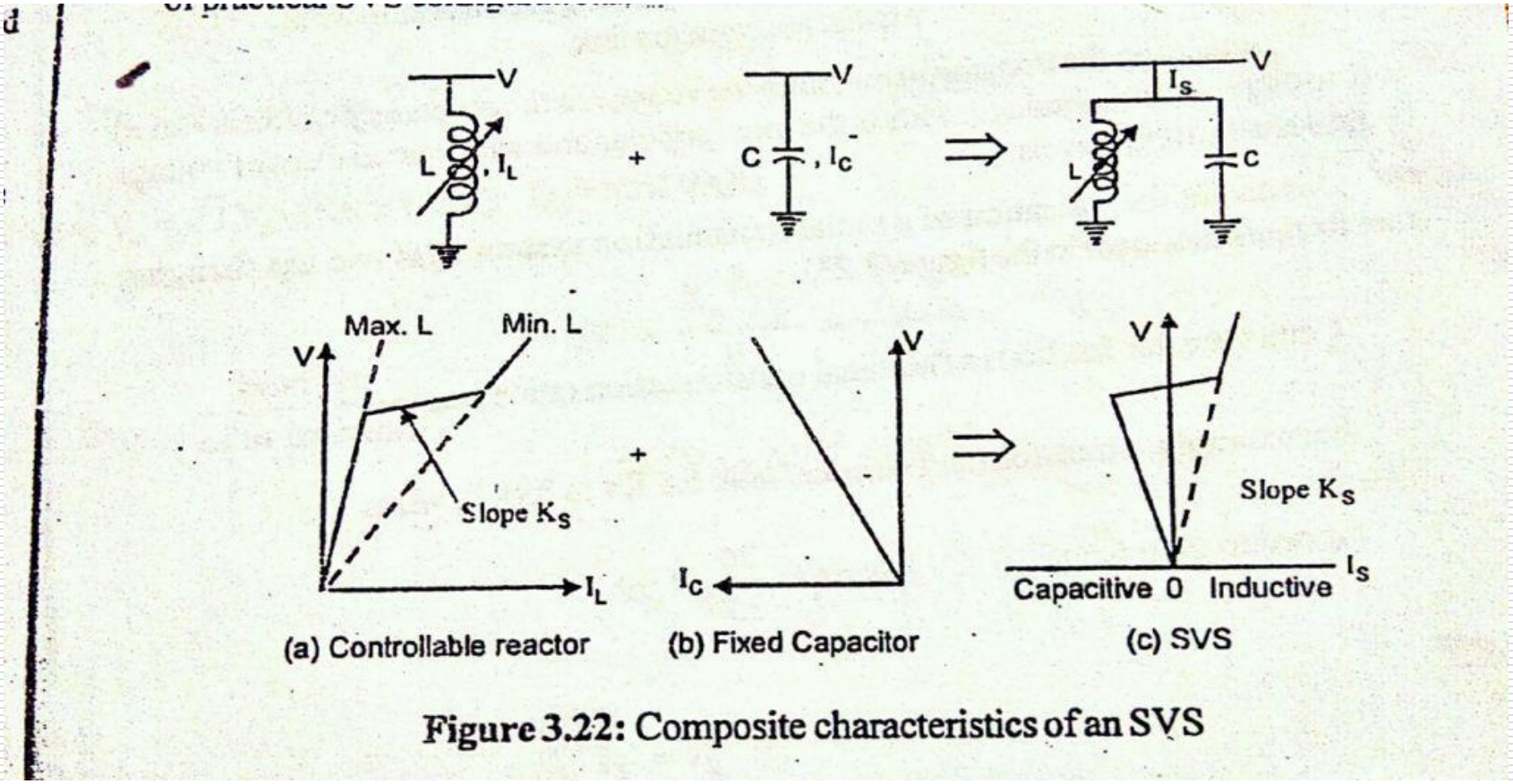


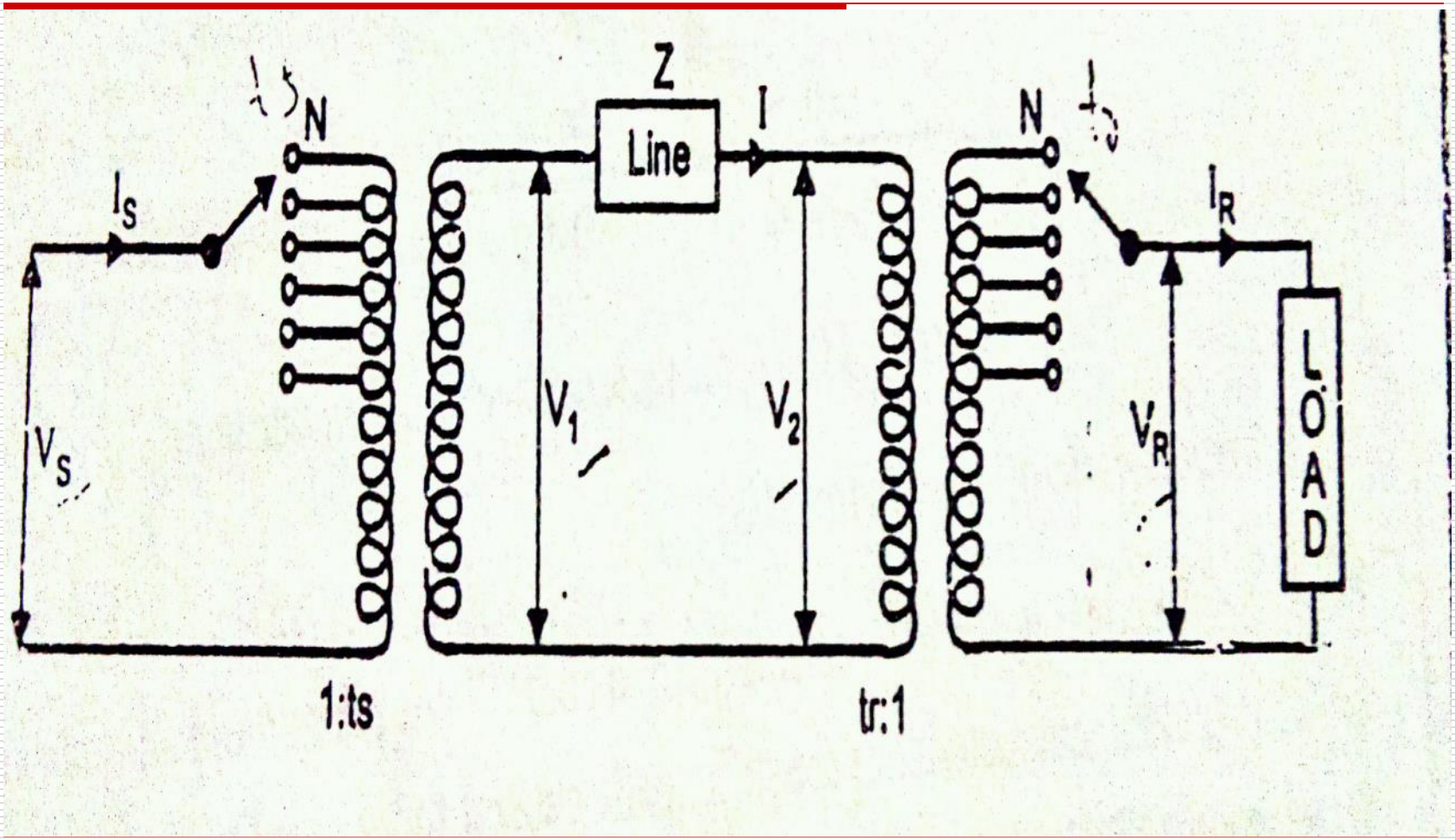
Figure 3.22: Composite characteristics of an SVS

Tap Changing Transformers

- The voltage control of Transmission and distribution systems is obtained by Tap changing.
- Tap changing are either ON-load or off load changer.By changing the turns ratio of T/F,the secondary voltage is changed and thus voltage control is obtained

- $V2/V1=t_s\text{^}2[1-(RP+XQ)/V1V2]$ (tstr =1)

Tap Changing Transformers diagram



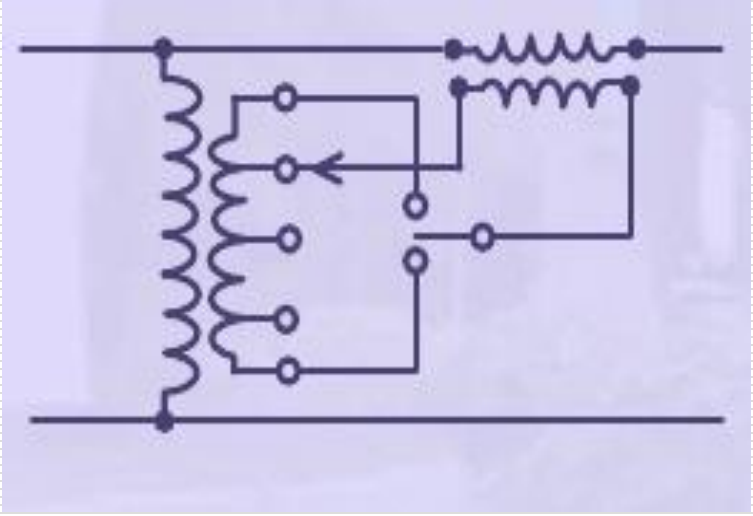
Booster Transformer

❖The two winding load tap changing transformer performs two function, transforming the voltage and boosting the voltage.

Location

❖It can be installed at a sub station.

❖Intermediate point in a line.(for voltage regulation)



Conclusion

- Synchronous condenser is better to over shunt and series capacitor if we need wider range of operation.
- SVC is more beneficial as it does not contain any rotating parts.

GALGOTIAS UNIVERSITY

THANK YOU