



# Power Electronics in the advancement of Power Systems

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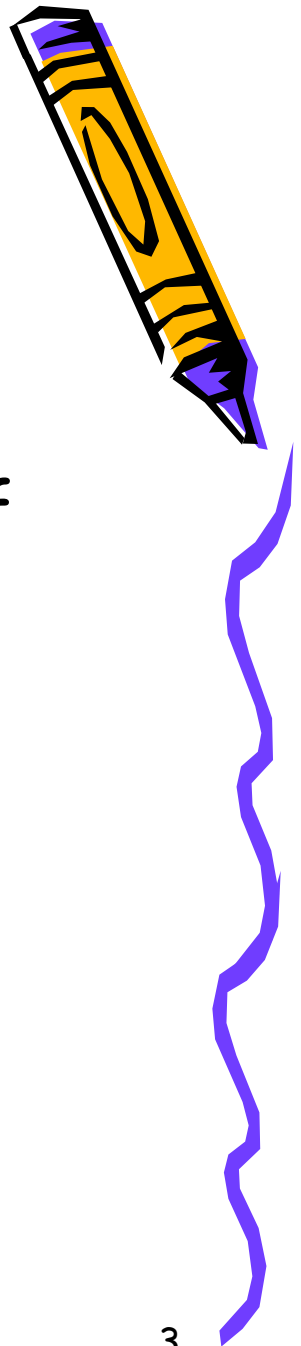
# Semiconductors

- Historically power electronics age began with the invention of glass bulb mercury arc rectifier in 1901.
- The modern era of solid state power electronics started with the invention of thyristor (or silicon controlled rectifier) in 1948.
- Thyristors are latched on by a control system but must be turned off by the power circuit.



# Thyristors

- The SCRs produced now with voltage rating of 5-7 kV and average current of 4000A.
- The thyristors can be sub divided into following types-
  - Forced commutated Thyristor
  - Line commutated Thyristor
  - Reverse conducting Thyristor (RCT)
  - Gate turn off Thyristor (GTO)



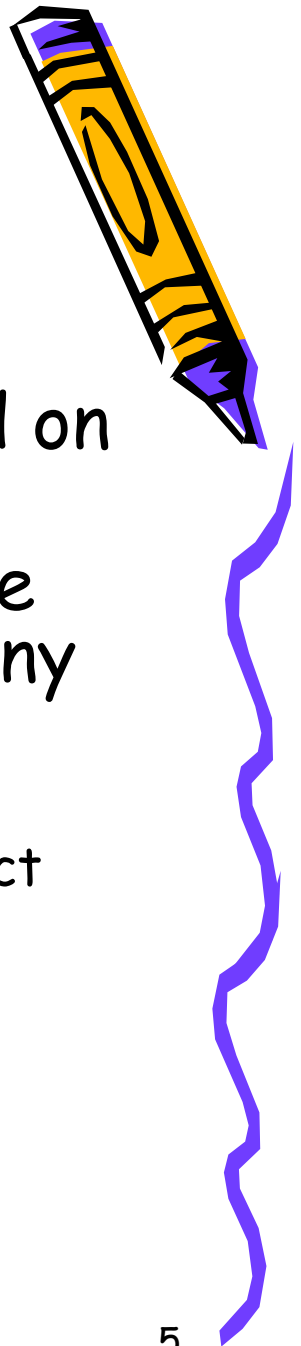
# Thyristors

- Static Induction Thyristor (SITH)
- Light activated SCR (LASCR)
- MOS controlled Thyristor (MCT)



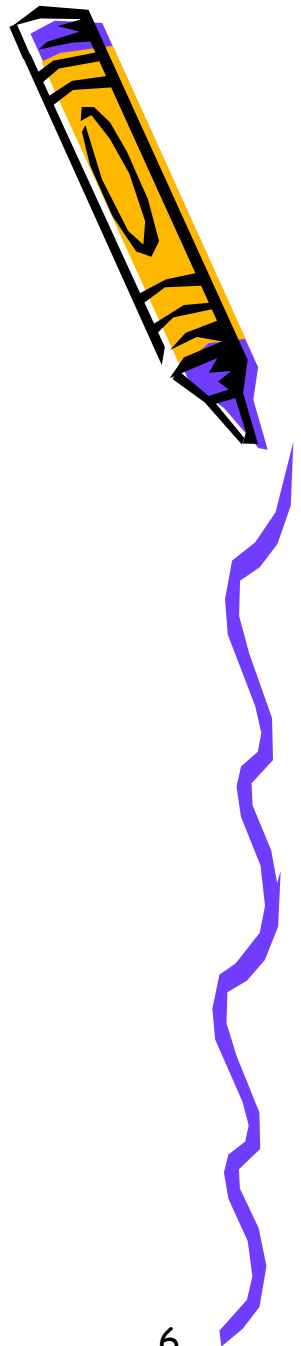
# Controllable Switches

- Controllable switches (1970) are turned on and off by control signals.
- The controllable switch category include the transistor family of devices and many others too, to name a few, they are
  - BJT (Bipolar Junction Transistor)
  - MOSFET (Metal oxide semiconductor field effect transistor)
  - GTO (Gate turn off thyristor)
  - IGBT (Insulated gate bipolar transistor)

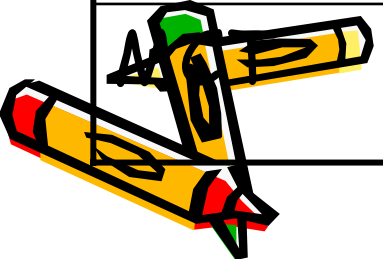
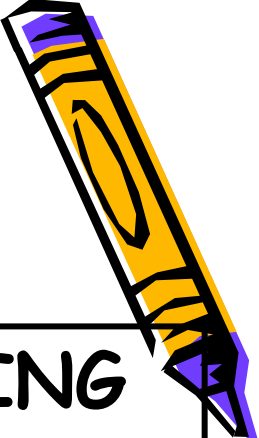


# Controllable Switches

- SITH (Static induction thyristor)
- MCT (MOS controlled thyristor)
- IGCT (Integrated gate commutated thyristor)
- SIT (Static induction transistor)



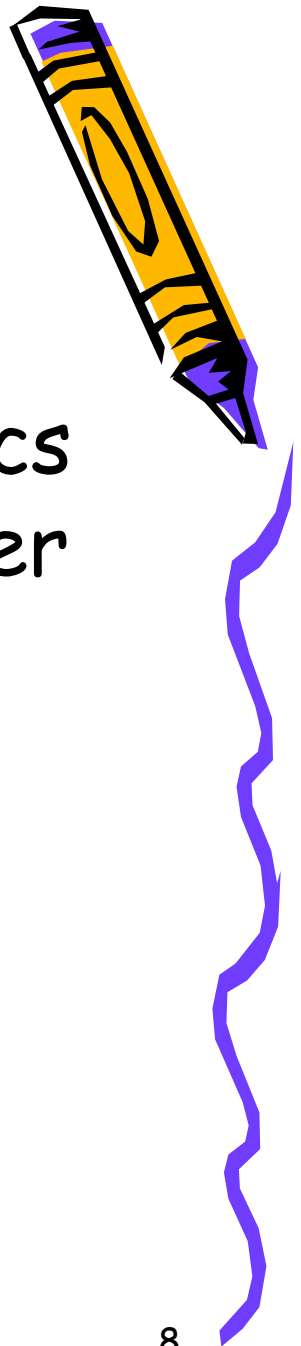
# Relative Properties of Controllable Switches



DEVICES	POWER CAPABILITY	SWITCHING SPEED
BJT	Medium	Medium
MOSFET	Low	High
GTO	High	Slow
IGBT	Medium	Medium
	Medium	Medium

# HVDC

- The application of power electronics to power system started with power transmission through HVDC transmission.



# FACTS Devices

- Various types of FACTS devices are
  - Static VAR Compensators (SVC)
  - Thyristor Controlled Series Compensator (TCSC)
  - Thyristor Controlled Phase Angle Regulator (TCPAR)
  - Static Compensator (STAT COM)
  - Unified Power Flow Controller (UPFC)
  - Static Synchronous Series Compensator (SSSC)



# FACTS Devices

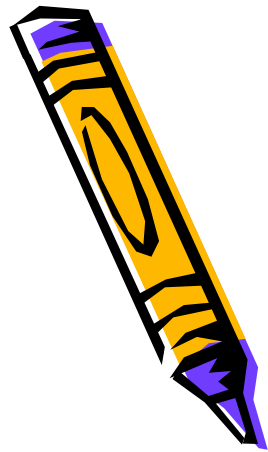


- SVC- There are two building blocks ,thyristor switched capacitor (TSC) and thyristor controlled reactor (TCR). The SVC can regulate the bus voltage by controlled reactive power injection.
- TCSC- It contains a capacitor in parallel with the TCR. This is a series compensation devices.
- STAT COM- It is a shunt device and doesn't require inductor or capacitor. It uses a GTO based VSI. The STAT COM can absorb or generate reactive power.



# FACTS Devices

- SSSC- It is a series compensator in which a synchronous VSI injects fundamental voltage in series with the line current
- UPFC-This contains two VSI that are connected together through a de link. It can act as both shunt controller and series controller and also as phase angle regulator
- IPFC (Inter line Power Flow Controller)- It is a FACTS controller to control power flow in multi line system.



# Custom Power Devices



- The FACTS devices allows the transmission lines to be loaded up to their thermal limits.
- In a similar way ,in the distribution system power electronic devices can be used to increase reliability and quality of electric power supply, the devices are called custom power devices.
- The DSTATCOM,DVR and UPQC are the devices and they are analogous to STATCOM, SSSC and UPFC in FACTS devices.
- The operating principle of custom power devices differ from the FACTS devices.





THANK YOU

