# Power System-II

# Lecture-1

Power System Transients on a transmission line, short circuit of synchronous machine at no load and on full load.

# Topic Covered

- Introduction of Power System
- Complications
- Electrical Transient
- RC Circuit Response

# Simple Power System

- Every power system has three major components:
  - **generation**: source of power, ideally with a specified voltage and frequency
  - **load** or **demand**: consumes power; ideally with a constant resistive value
  - **transmission system**: transmits power; ideally as a perfect conductor
- Additional components include:
  - **distribution system**: local reticulation of power,
  - **control equipment**: coordinate supply with load.

# Complications

- No ideal voltage sources exist.
- Loads are seldom constant and are typically not entirely resistive.
- Transmission system has resistance, inductance, capacitance and flow limitations.
- Simple system has no redundancy so power system will not work if any component fails.

# Power

- Power:
  - Instantaneous rate of consumption of energy,
  - How hard you work!
- Power = voltage x current for dc
- Power Units:

Watts = amps times volts (W)

kW - $1 \times 10^3$ Watt

MW - $1 \times 10^6$ Watt

GW - $1 \times 10^9$ Watt

# Energy

- Energy:
  - Integration of power over time,
  - Energy is what people really want from a power system,
  - How much work you accomplish over time.
- Energy Units:

  Joule = 1 watt-second (J)

  kWh - kilowatthour ($3.6 \times 10^6$ J)

  Btu - 1055 J;

  1 MBtu=0.292 MWh

# Electrical Transients

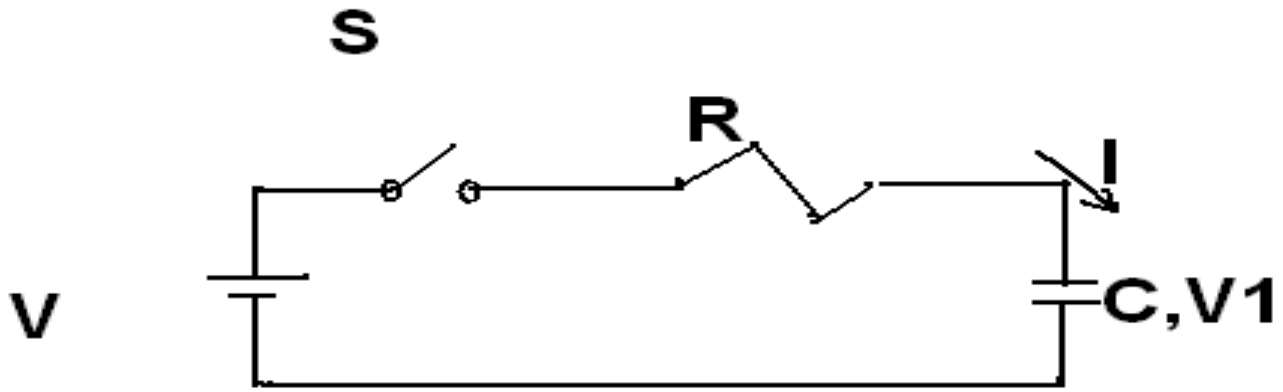
- Time Scale in Power System Studies:
  planning, Load Flow, Dynamic Stability
  Switching, external disturbances
- Frequency Content
- Differential Equations Solution
- Distributed  and Lumped Parameters

# CCT Parameters

- In Steady State and Transient

- Mathematical Presentation & Physical Interpretation

# Simple RC Circuit, Closing Ideal Sw.



# Equations of RC Circuit

$$V = IR + \frac{1}{C}\int Idt \qquad I = \frac{dQ}{dt} = C\frac{dV_1}{dt}$$

$$V = RC\frac{dV_1}{dt} + V_1$$

$$\frac{dV_1}{V - V_1} = \frac{dt}{RC}$$

# RC Circuit Response

$$\ln(V - V_1) = -\frac{t}{RC} + Cons.$$

$$V_1 = V - [V - V_1(0)]e^{-t/RC}$$

$$V_1 = V - Ae^{-t/RC}$$

# RC Circuit Response

$$\ln(V - V_1) = -\frac{t}{RC} + Cons.$$

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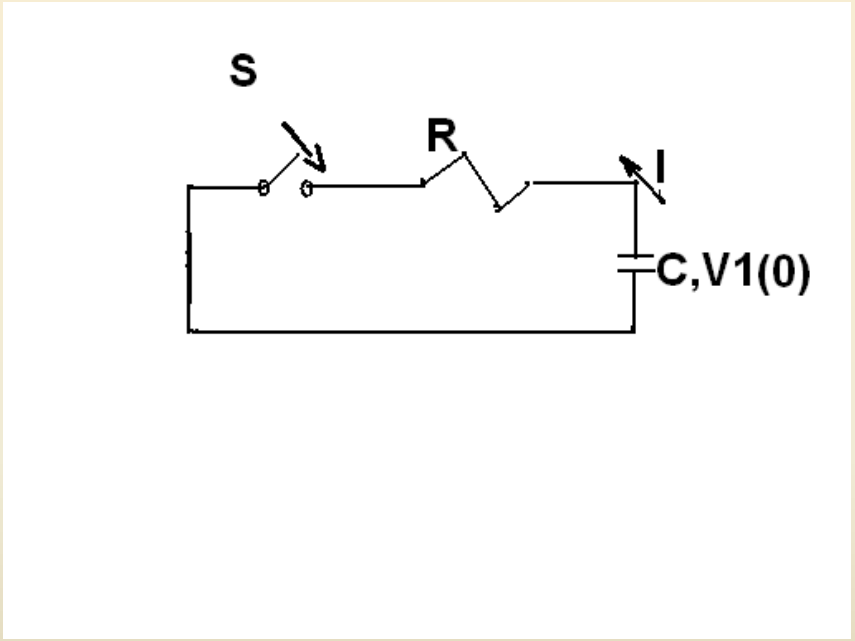
$$V_1 = V - Ae^{-t/RC}$$

# RC Circuit Discharge

$$RC\frac{dV_1}{dt} + V_1 = 0$$

$$V_1 = V_1(0)e^{-t/RC}$$



# Capacitor Voltage of RC CCT