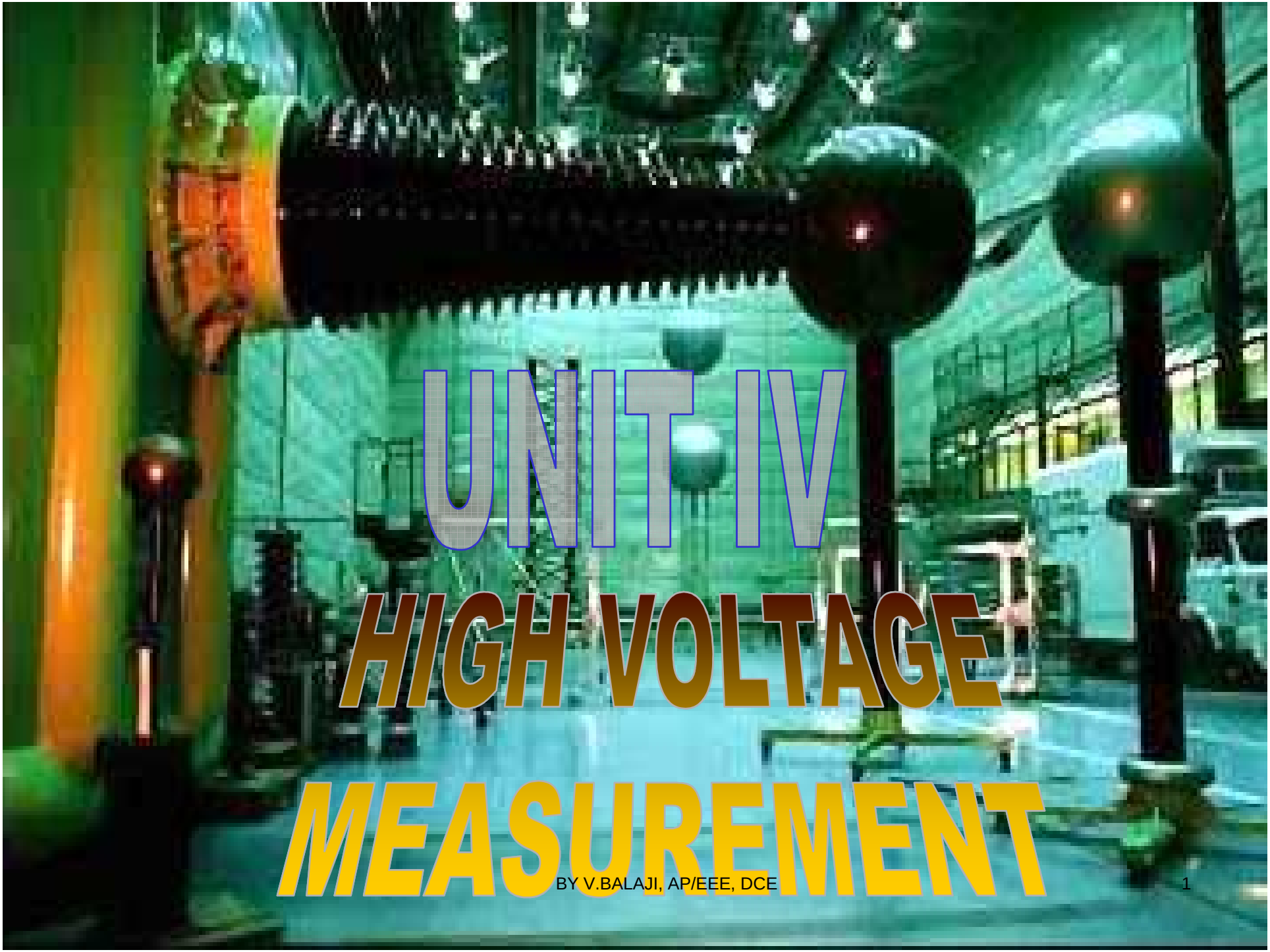


UNIT IV

HIGH VOLTAGE MEASUREMENT

High Voltage Measurement Techniques

Type	Method/Technique
(a) DC Voltages	(i) Series Resistance Microammeter (ii) Resistance Potential Divider (iii) Generating Voltmeter (iv) Sphere and Other Spark gaps
(b) AC Voltages (Power Frequency)	(i) Series impedance Ammeter (ii) Potential dividers (iii) Potential Transformers (iv) Electrostatic Voltmeters (v) Sphere gaps

High Voltage Measurement Techniques

Type	Method/Technique
(c) AC high frequency Voltages, Impulse voltages, and other rapid change voltages	(i) Potential dividers with CRO (ii) Peak Voltmeters (iii) Sphere gaps

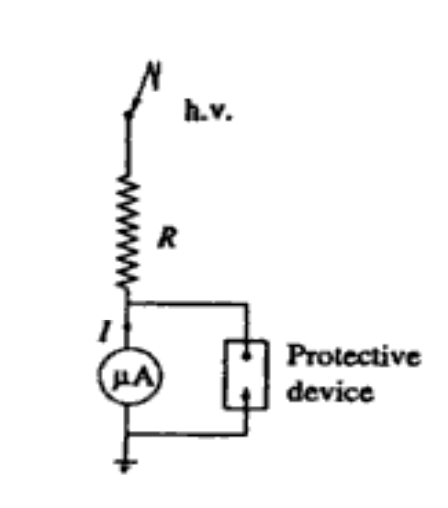
High Current Measurement Techniques

Type	Method/Technique
(a) Direct Currents	(i) Resistive Shunts with milliammeter (ii) Hall Effect Generators (iii) Magnetic Links
(b) Alternating Currents (Power Frequency)	(i) Resistive shunts (ii) Electromagnetic current Transformers
(c) High frequency AC, impulse and rapid change currents	(i) Resistive shunts (ii) Magnetic Potentiometers (Rogowski Coils) (iii) Magnetic Links (iv) Hall Effect Generators

HVDC Measurement

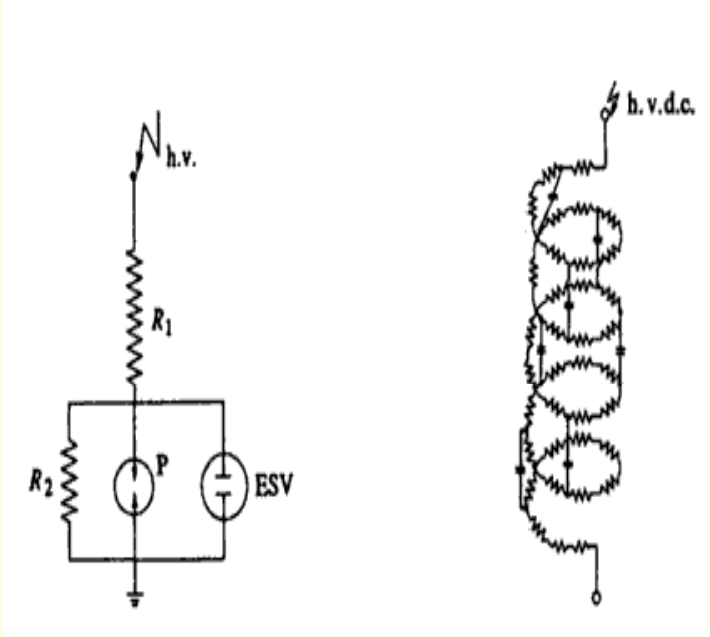
- Series Resistance Ammeter
- Resistance Potential Dividers
- Generating Voltmeter
- Oscillating Spheroid
- Ripple Voltage Measurement

Series Resistance Ammeter



- Voltage drop in meter negligible
- Permissible – 5 kV/cm in air – 20 kV/cm in good oil
- Limitations:
  - Power Dissipation and Source Loading
  - Temperature effects and Long time stability
  - Voltage dependence of resistive elements
  - Sensitivity to mechanical stresses

Resistance Potential Dividers



- Influence of temp and voltage is eliminated
- HV magnitude.

  $=(1+[R_1/R_2])\ V_2$
- Voltage controlling capacitors- avoid sudden changes switching operations, flash over due to stray and ground capacitance.
- Accuracy
  - 0.05% upto 100 kV
  - 0.1% upto 300 kV
  - 0.5% for 500 kV

a) Resistance Potential divider with an electrostatic voltmeter
b) Series resistor with parallel capacitors for potential linearization for transient voltages

P-Protective devices
ESV-Electrostatic Voltmeter

Generating Voltmeter

- Variable capacitor electrostatic voltage generator
- Current through the capacitor,

$$I = dq / dt = VdC/dt + CdV/dt$$

For dc voltages, $i=VdC/dt$

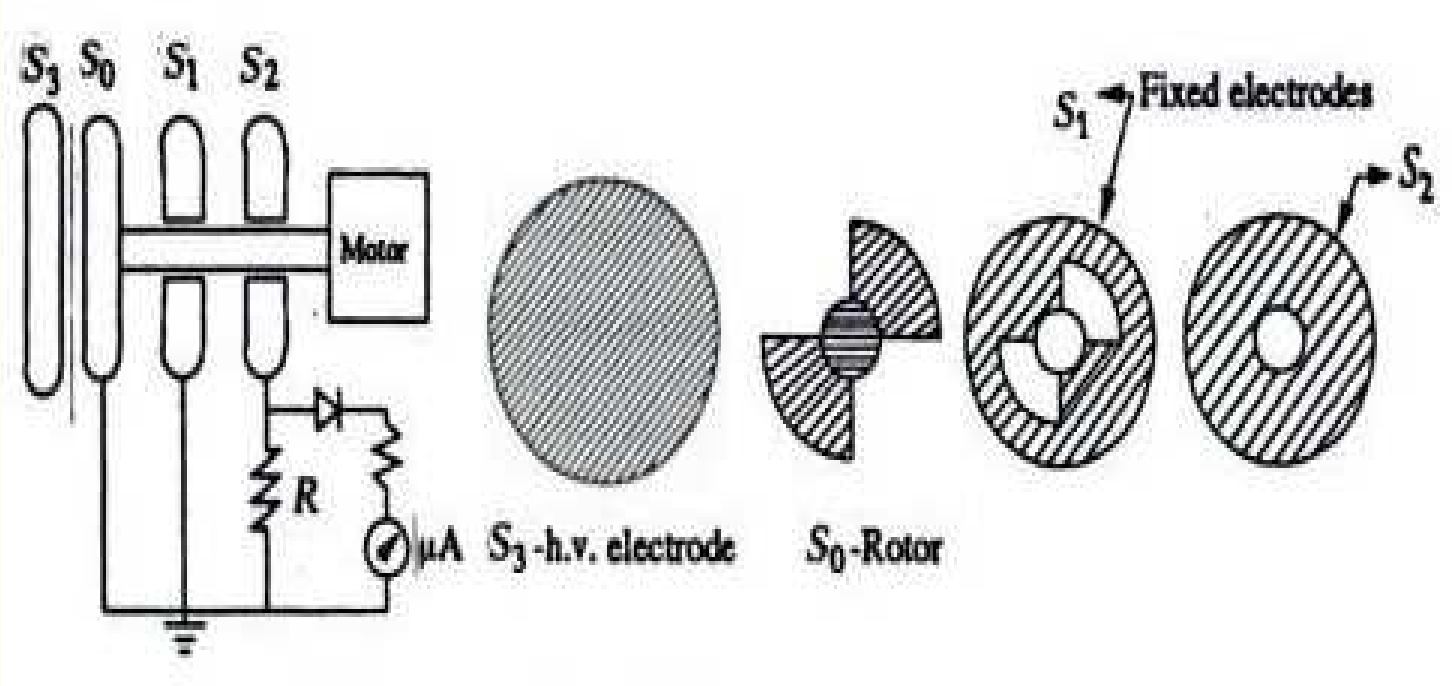
$$C=C_0 + C_m \sin\omega t$$

$$i= i_m \cos \omega t \text{ where, } i_m=VC_m \omega$$

$$\text{Rms value of the current} = VC_m \omega /\sqrt{2}$$

- Current proportional to Applied Voltage

Generating Voltmeter



Generating Voltmeter

- Ac flowing through two halves

$$i=n\,\Delta C\,V\,/30$$

Where, n=speed of synchronous motor,

$$\Delta C = C_{max} - C_{min}$$

- HV source is connected to S_3
- S_0 is driven by const speed synchronous motor.

Advantages and Disadvantages

- Advantages:
  - No source loading by the meter
  - No direct connection to HV electrode
  - Scale is linear and extension of range is easy
  - Convenient instrument for electrostatic devices such as Van de Graaf Generator and Particle accelerators
- Disadvantages:
  - Require calibration
  - Careful construction and cumbersome instrument requiring an auxiliary drive
  - Disturbance in position and mounting of the electrodes make the calibration invalid

Oscillating Spheroid

- Period of oscillation ∝ Applied electric field

$$E \propto V \propto [f^2 - f_0^2]$$

- Spacing – 50 cm
- One electrode earthed, other is connected to HV DC source.
- Measured voltages 200 kV, accuracy 0.1%
- 145 cm diameter with 45cm spacing.
- Complicated, and time consuming method.
- Not widely used

Ripple Voltage measurement

- Simple RC Circuit.
- If V_1- DC Source Voltage, V_2= voltage across resistance. Then Ripple Voltage

$$V_r=V_1(t)-V_{dc}$$

- C is rated for peak voltage
- S is closed when CRO is connected to the source
- C should be larger than capacitance of cable and input capacitance

Measurement of HVAC

- Series impedance Voltmeters
- Capacitance potential dividers and Capacitance Voltage Transformers
- Potential Transformers (Magnetic Type)
- Electrostatic Voltmeter
- Peak reading AC Voltmeter
  - Series Capacitor
  - Potential divider