



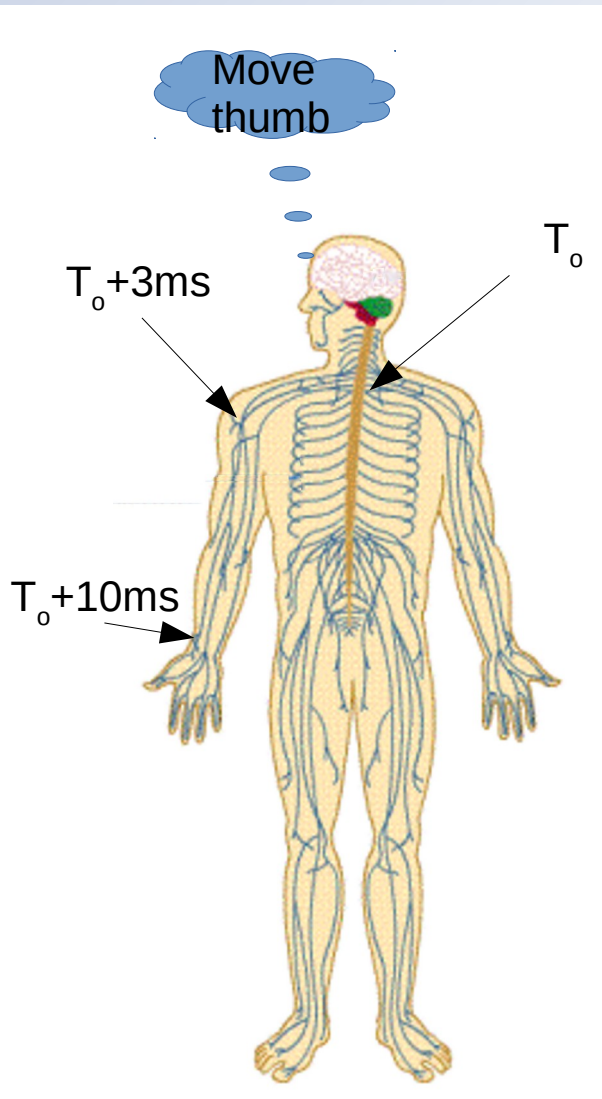
Electrical Stimulation Electrodes

Suresh Devasahayam
Department of Bioengineering
Christian Medical College, Vellore

Lecture - Outline

- Electrical Stimulation
 - Excitable Tissue
 - Action Potentials
- Application of Artificial Stimulation
 - Cardiac Pacemakers
 - Functional Electrical/ Neuromusc Stim
 - Deep Brain Stimulation
- Constant Voltage and Constant Current Stim
- Electrochemical Reactions
 - Polarization
 - Charge Balancing

Nerve Signalling – information transmission

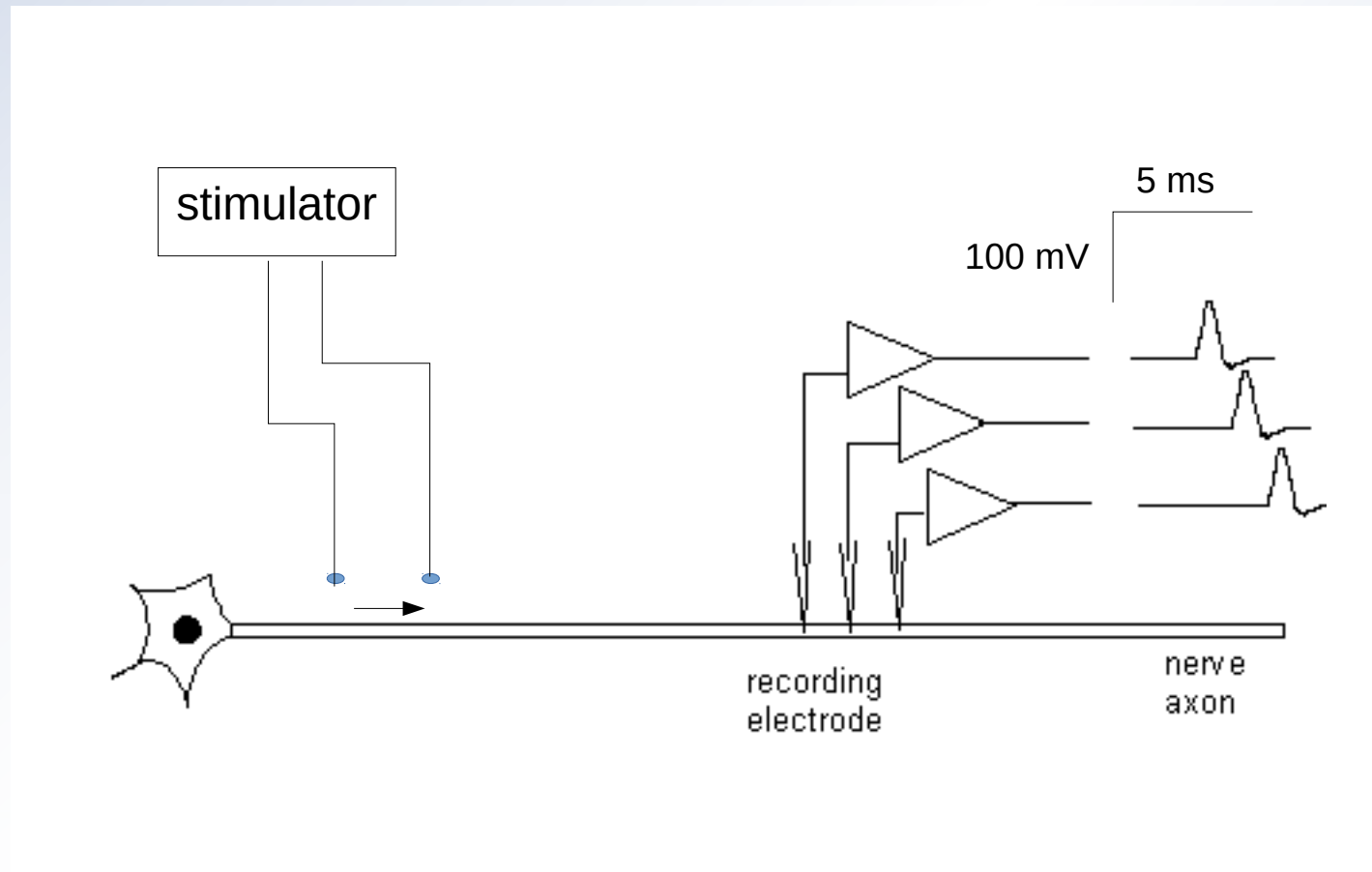


- Nerve signals propagate at about 100 m/s
- Information is frequency encoded by nervous system
- End-organs decode, i.e., demodulate the frequency encoded signals
- For example, skeletal muscle fibres act as a demodulator

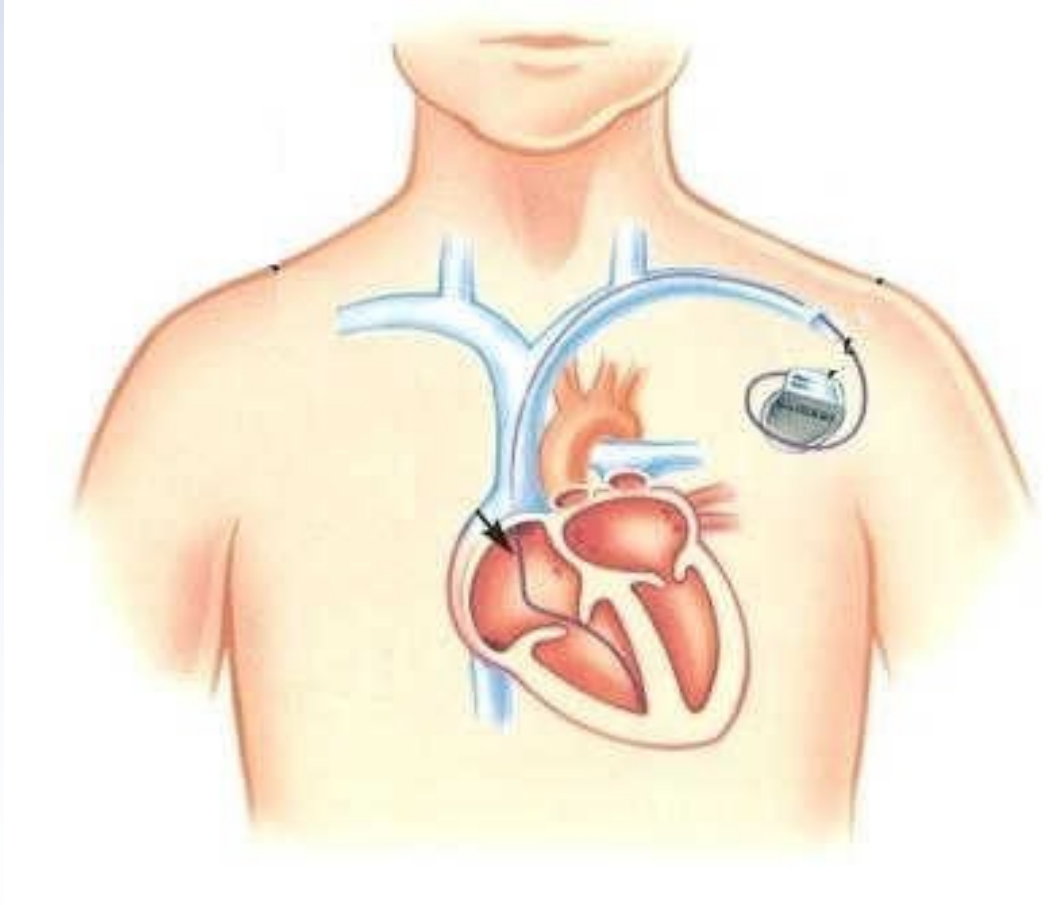
Nerve Action Potential is a Propagating Wave

- Nerve action potential travels from point of initiation
- It travels at a speed determined by the characteristics of the nerve membrane
 - Passive electrical properties
 - Insulation due to myelin
 - Ion channel dynamics
- Its propagation is like a travelling wave
- Similar to peristalsis in the gastrointestinal system where contraction moves as a wave

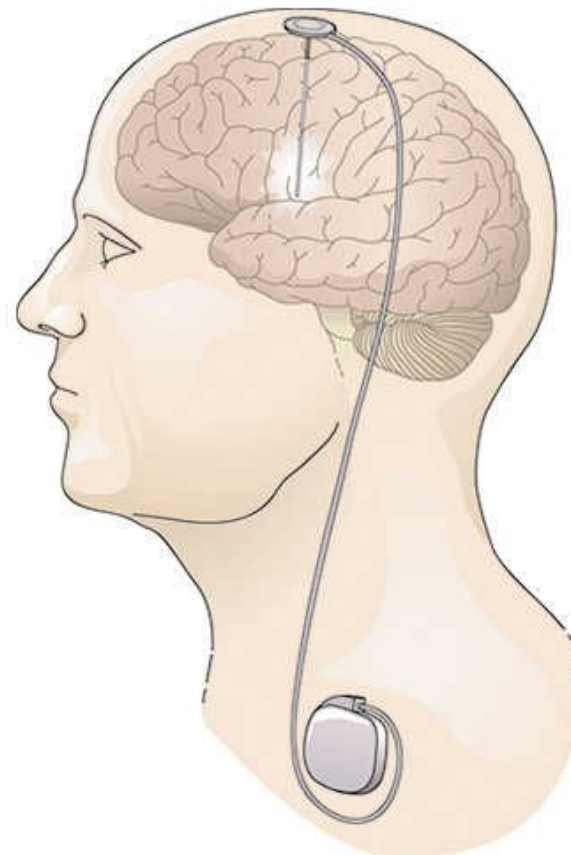
Initiating Action Potential by Elect Stim



Cardiac Pacemaker

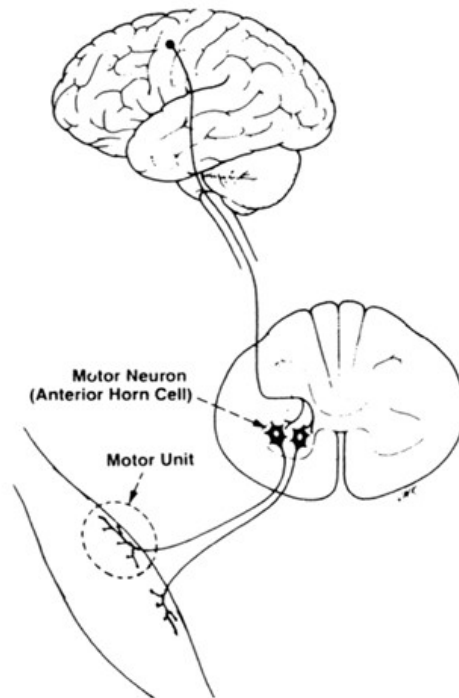


Deep Brain Stimulation



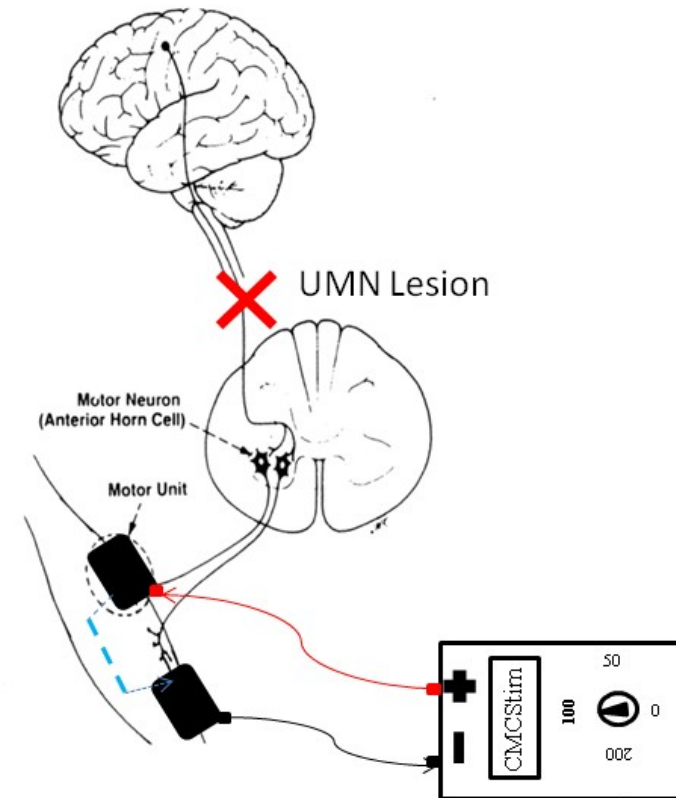
Spinal Injury, Muscle Paralysis & Artificial Stimulation

Natural / Healthy



a.) Normal Physiology

Pathology/Artificial Stimulation

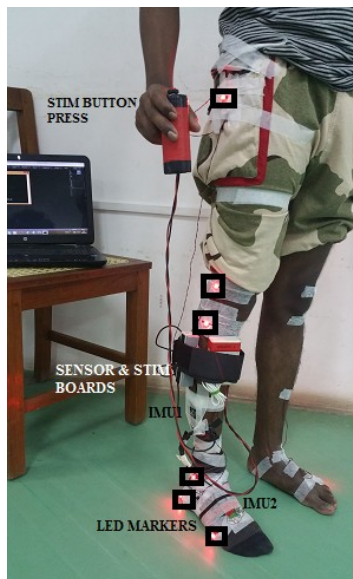
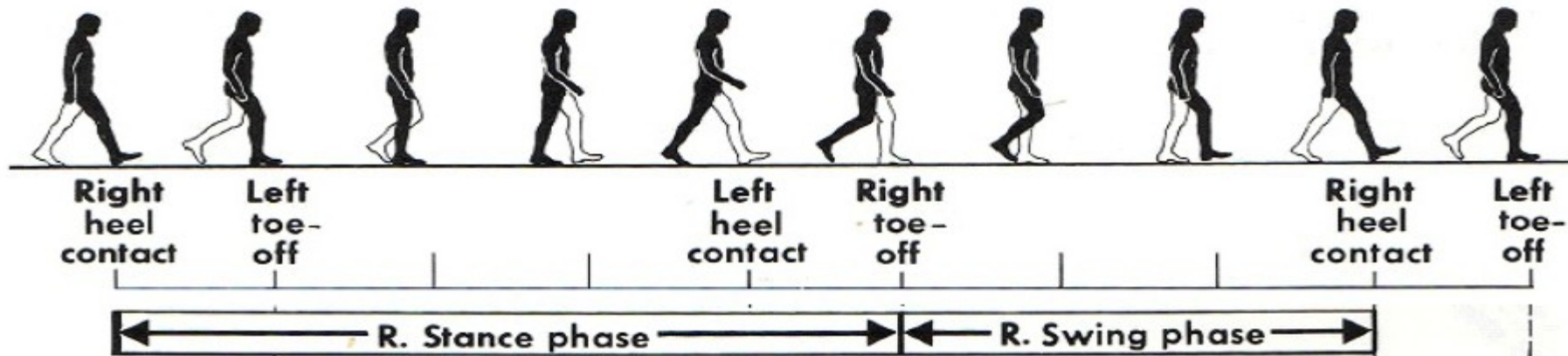


b.) Pathology and artificial compensation

Electrical Stimulation with Surface Electrodes



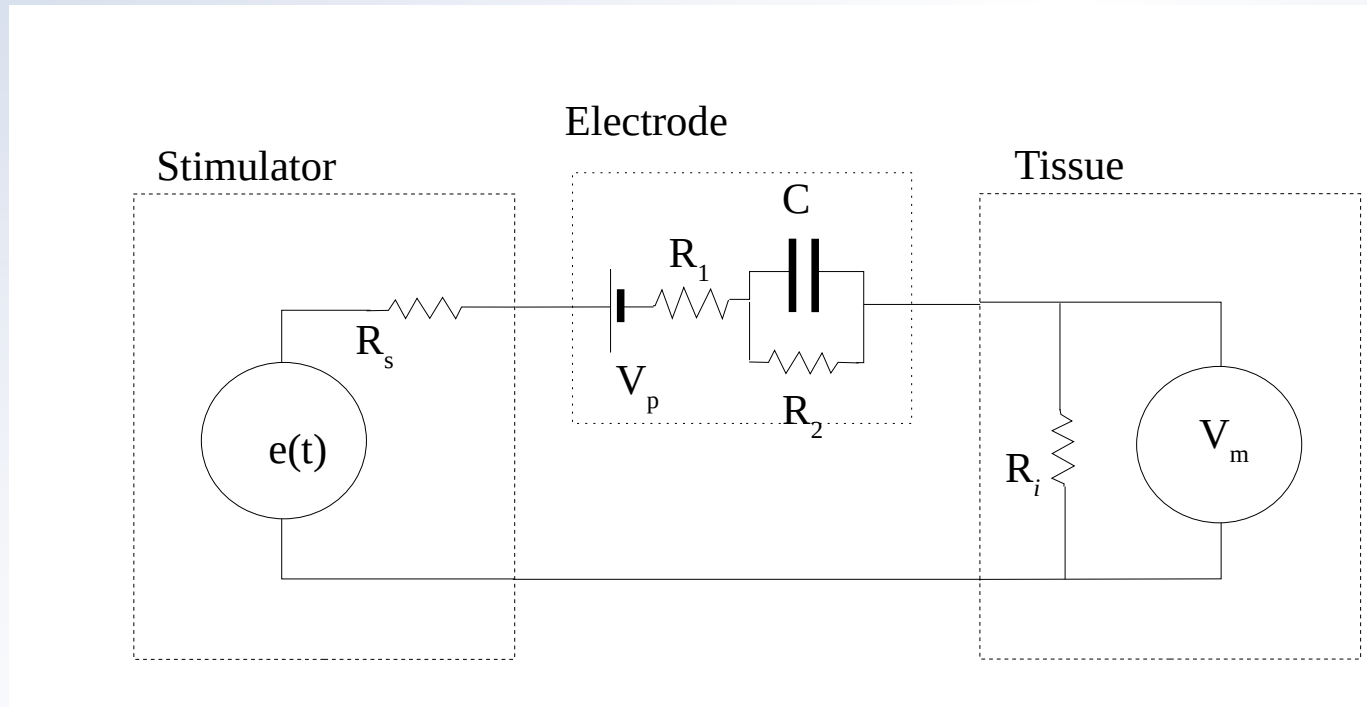
Foot Drop Correction (Naveen G, MS-Thesis)



Constant Voltage and Constant Current Stimulation

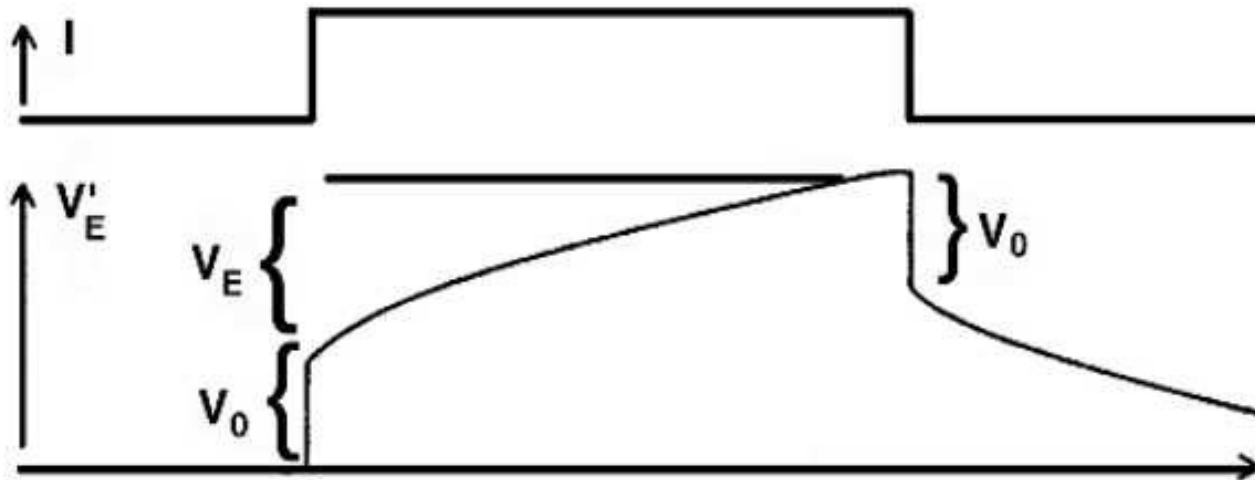
- Nerve stimulation threshold
 - Current along the nerve
- Constant voltage
 - Voltage drop across electrode alters effective current
- Constant current
 - Stimulus voltage adjusted to compensate for electrode impedance

Stimulation model



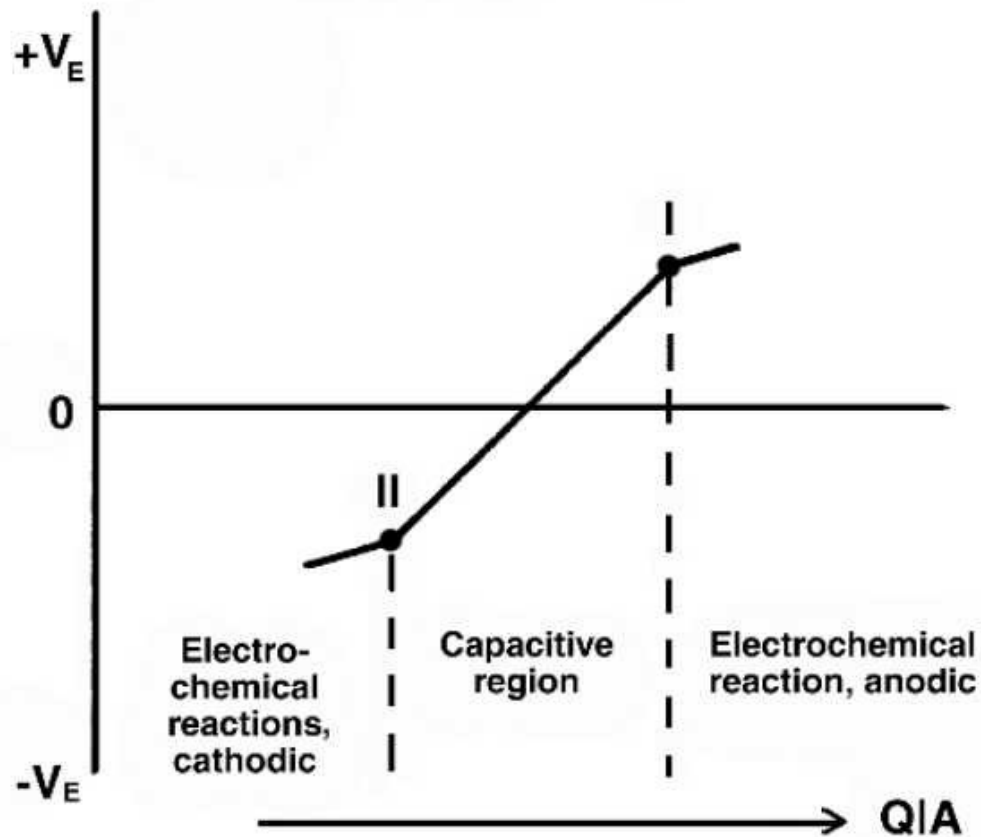
Charge accumulation in electrode-tissue interface

- Stimulus current charges capacitor

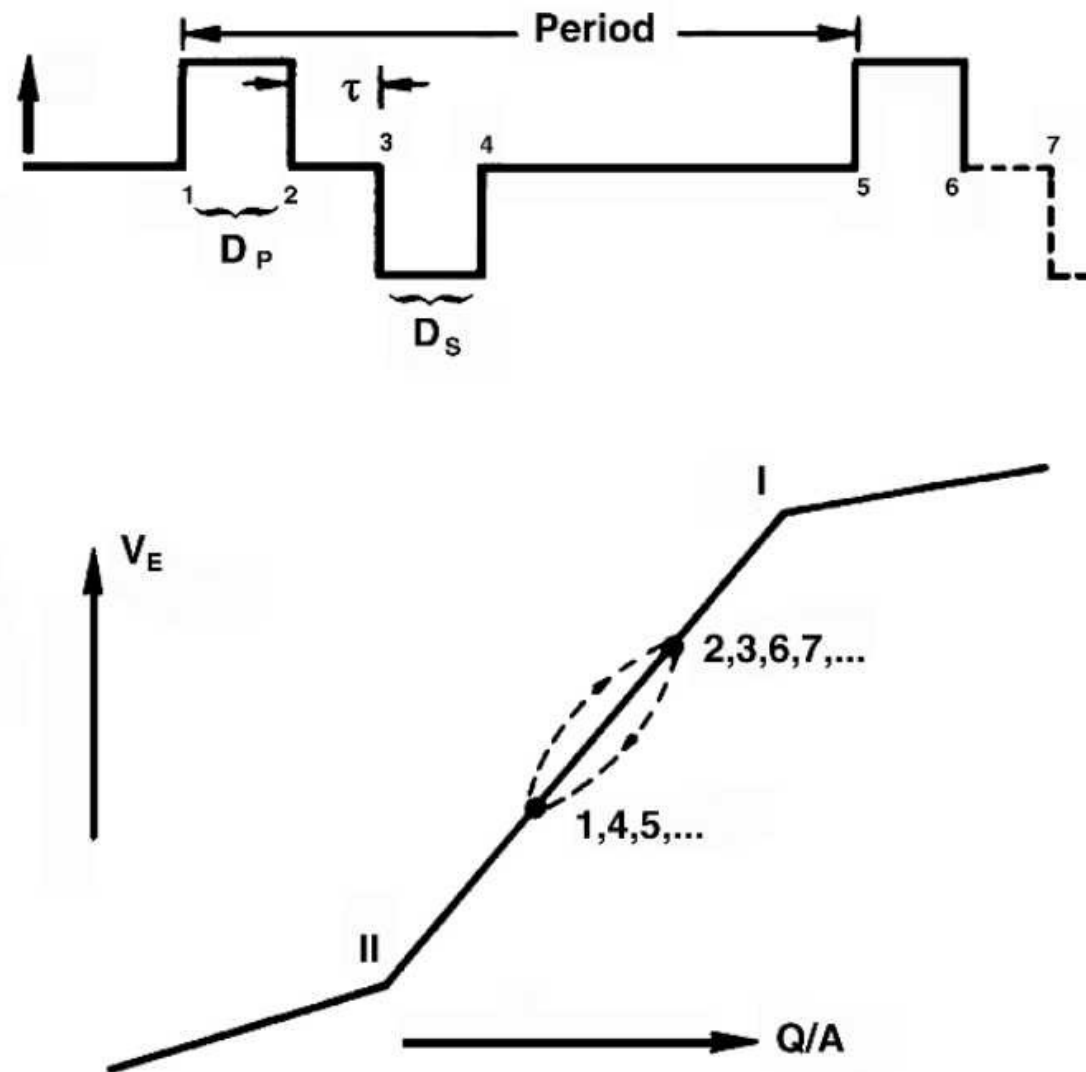


Stimulation Electrode Reactions

- Steel electrodes
 - $\text{Fe} \rightarrow \text{Fe}^{++} + 2\text{e}^-$
- Platinum electrodes



Charge Balancing



FES cycling – 01 (CMC-Vellore, 2019)



FES cycling – Sahil Gera MS Thesis



Brain stimulation



End of Lecture