DES535
Ubiquitous Computing

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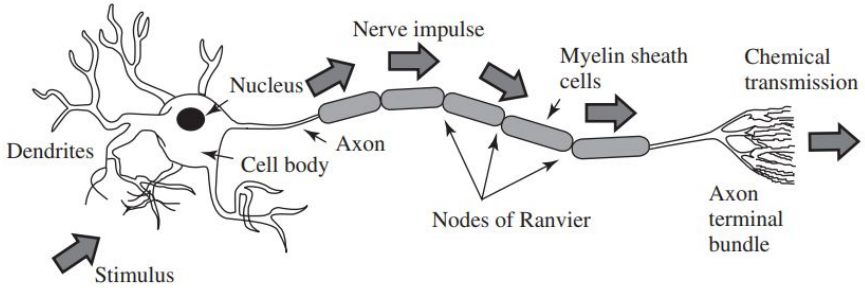
Google Classroom Code : pcwnf5t

Physiological Sensing

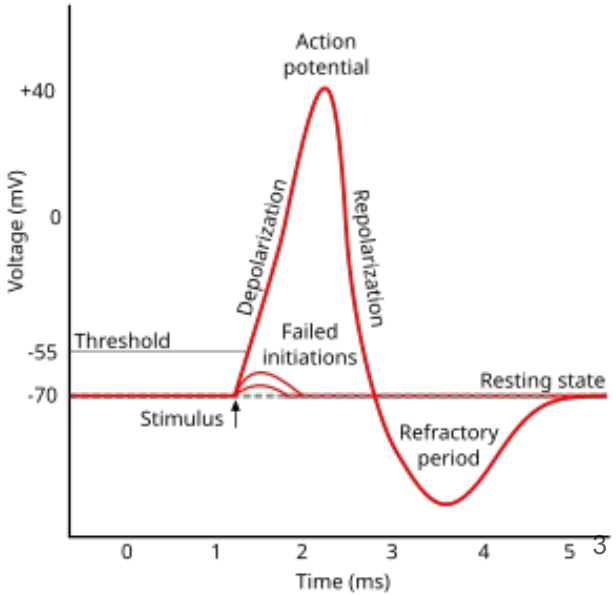
Module VI (Part II)

Electroencephalography (EEG) : Action Potential

- Electroencephalography is a medical imaging technique that reads scalp **electrical activity** generated by brain structures.



- Resting membrane potential : A potential of 60–70 mV with negative polarity may be recorded under the membrane of the cell body.
  - Why?
- An action potential is a series of quick changes in voltage across a cell membrane.



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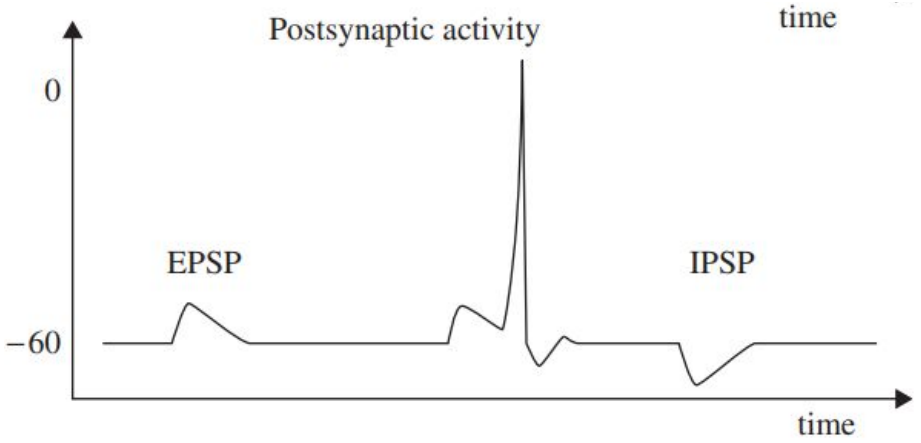
Electroencephalography (EEG) : Action Potential [Contd…]

- If an action potential travels along the fibre, which ends in an excitatory synapse, an excitatory postsynaptic potential (EPSP) occurs in the following neuron.
    - If two action potentials travel along the same fibre over a short distance, there will be a summation of EPSPs producing an action potential on the postsynaptic neuron providing a certain threshold of membrane potential is reached.
- If the fibre ends in an inhibitory synapse, then hyperpolarization will occur, indicating an inhibitory postsynaptic potential (IPSP)



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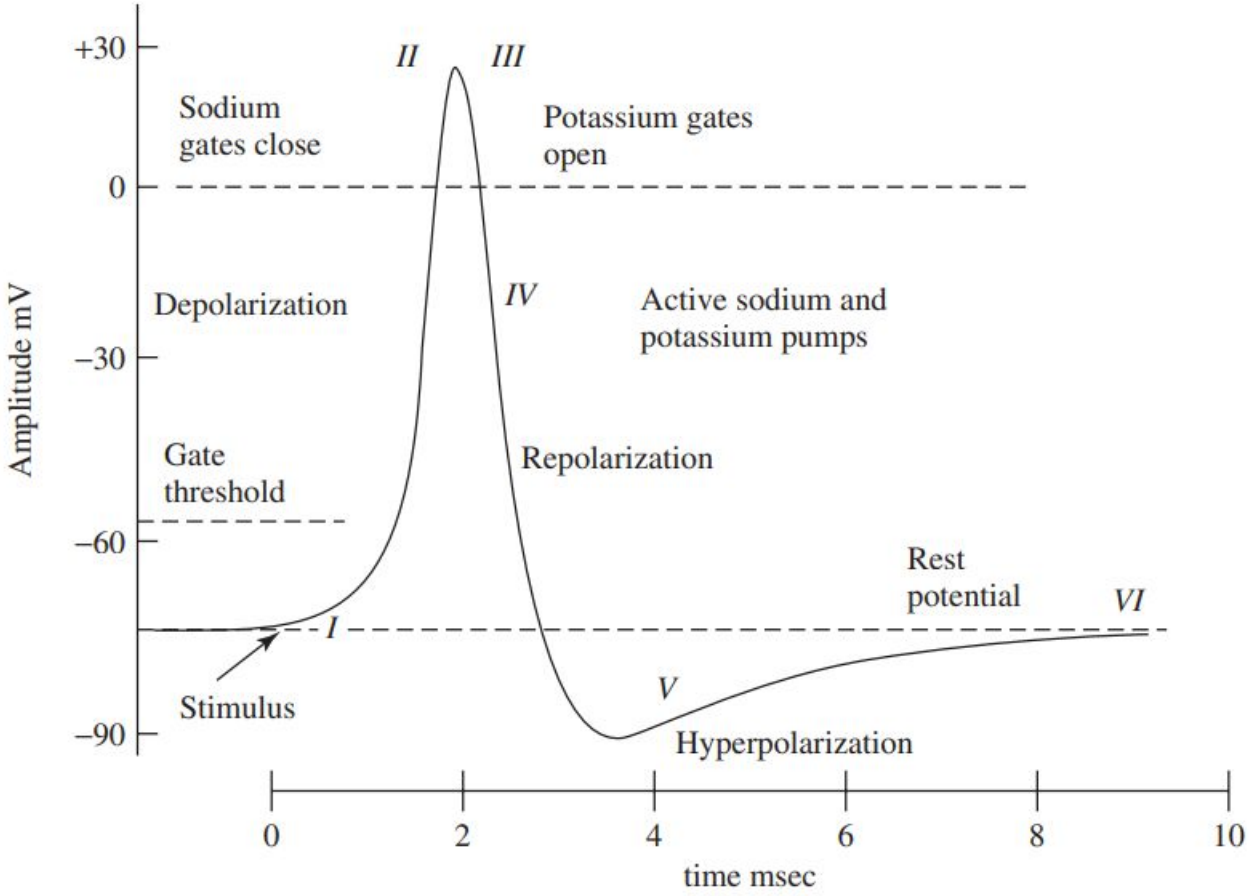
6 Phases of changes in the membrane potential



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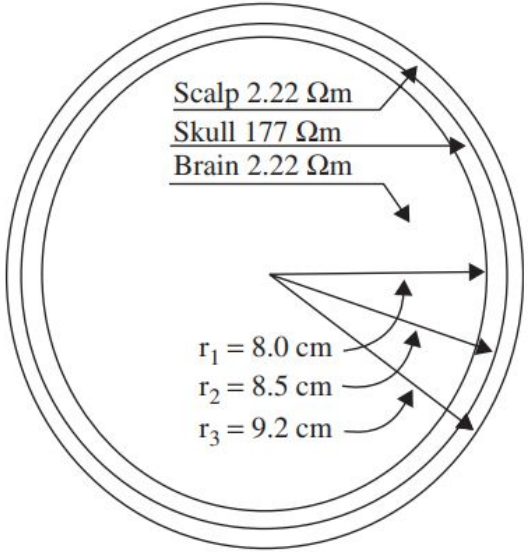
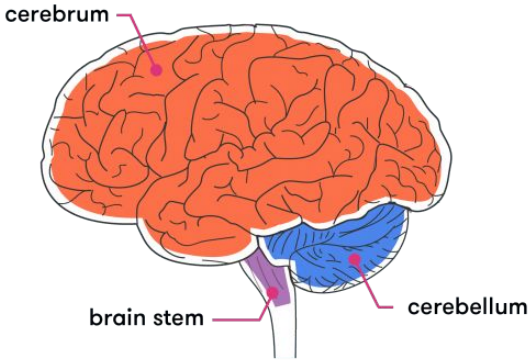
EEG Signal Generation

- Only large populations of active neurons can generate enough potential to be recordable using the scalp electrodes.
    - The skull attenuates the signals approximately one hundred times more than the soft tissue.
    - On the other hand, most of the noise is generated either within the brain (internal noise) or over the scalp (system noise or external noise).
- The cerebrum includes the regions for movement initiation, conscious awareness of sensation, complex analysis, and expression of emotions and behaviour.
- The cerebellum coordinates voluntary movements of muscles and maintains balance.
- The brainstem controls involuntary functions such as respiration, heart regulation, biorhythms, and neurohormone and hormone sections





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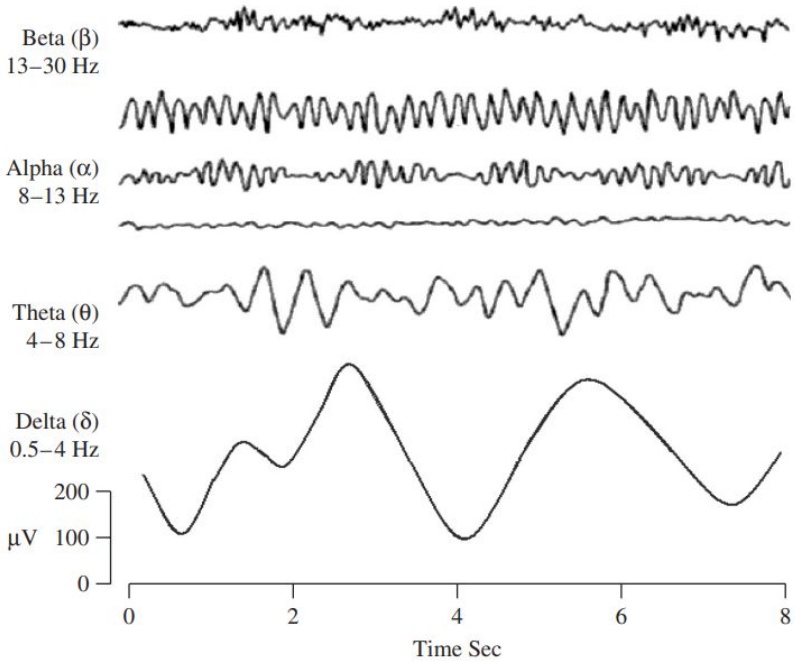
Frequency Bands of EEG Signal

- Delta : 0.5 – 4 Hz
  - These waves are primarily associated with deep sleep and may be present in the waking state.
- Theta : 4 – 7.5 Hz
  - Theta waves appear as consciousness slips towards drowsiness. Theta waves have been associated with access to unconscious material, creative inspiration and deep meditation.
- Alpha : 8 – 13 Hz
  - Alpha waves have been thought to indicate both a relaxed awareness without any attention or concentration.
  - Produced when eyes are closed.



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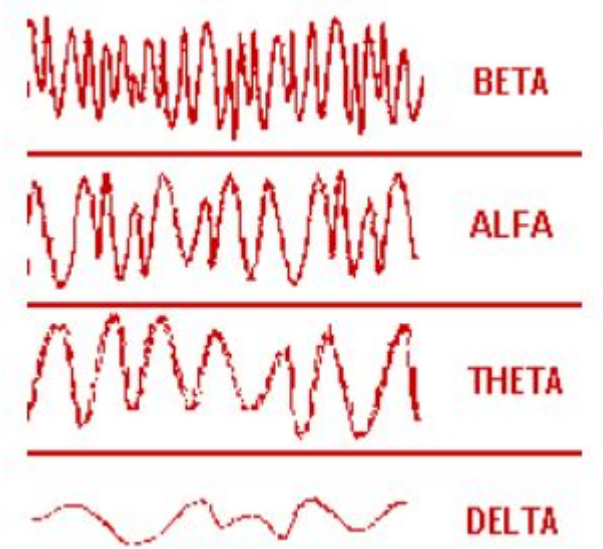
Frequency Bands of EEG Signal

- Beta : 14 – 30 Hz
  - A beta wave is the usual waking rhythm of the brain associated with active thinking, active attention, focus on the outside world, or solving concrete problems, and is found in normal adults.
  - A high-level beta wave may be acquired when a human is in a panic state.
- Gamma : 30 – 100+ Hz



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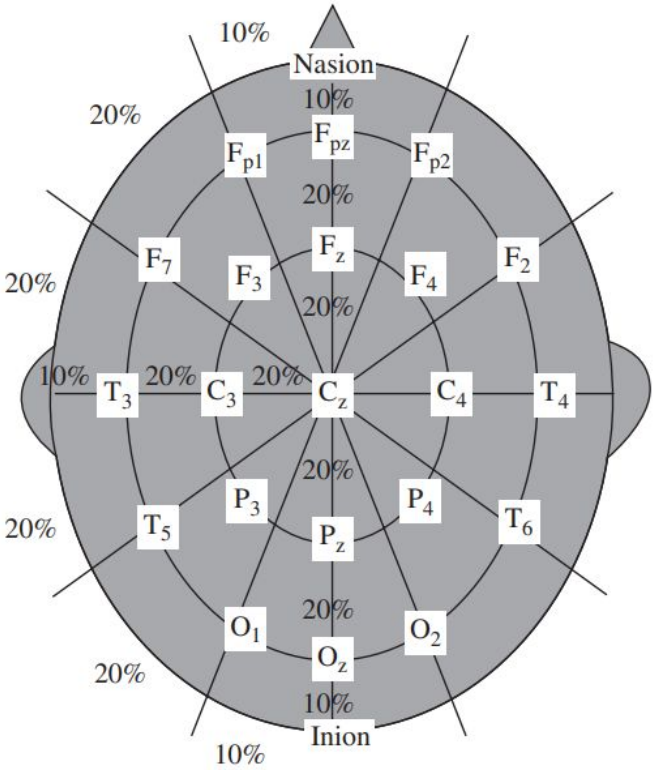
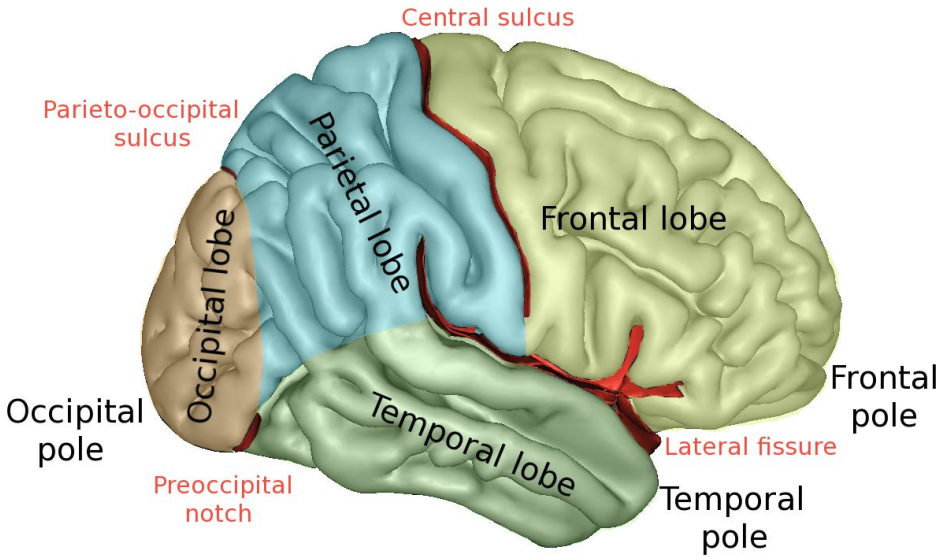
Electrode Positions





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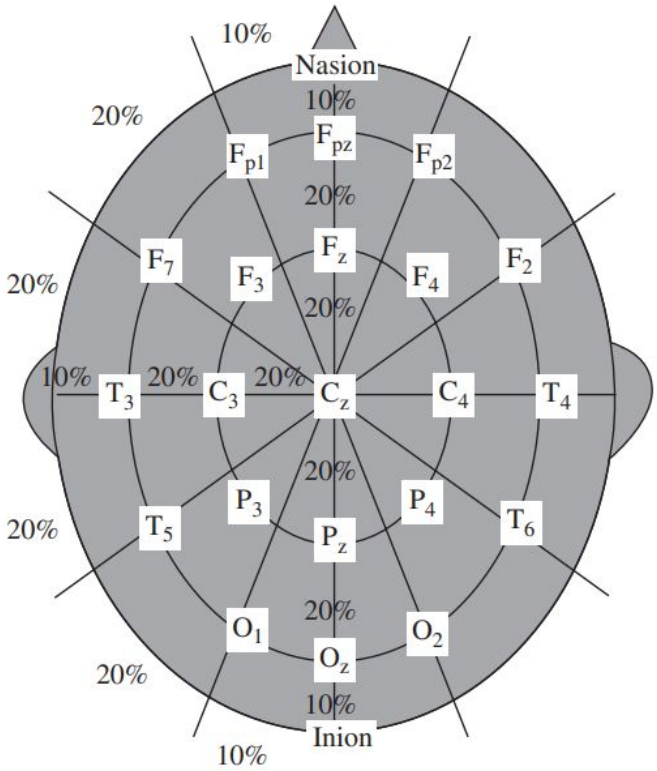

Letter	Meaning
Fp	Frontopolar
F	Frontal
C	Central
T	Temporal
P	Parietal
O	Occipital
A	Auricular
Z	Midline

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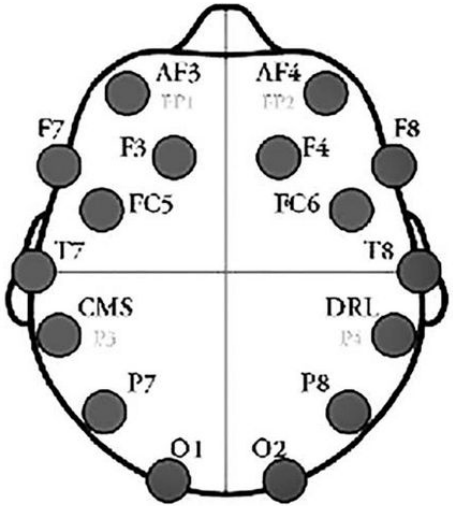
Some Commercial Devices

- Emotiv
- GTec
- Enobio 8



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Graded Activity

- Design (rough) an EEG device for monitoring distraction.
- Why would people use your solutions over the traditional systems?