

Circuits and Signals: Biomedical Applications Week 11

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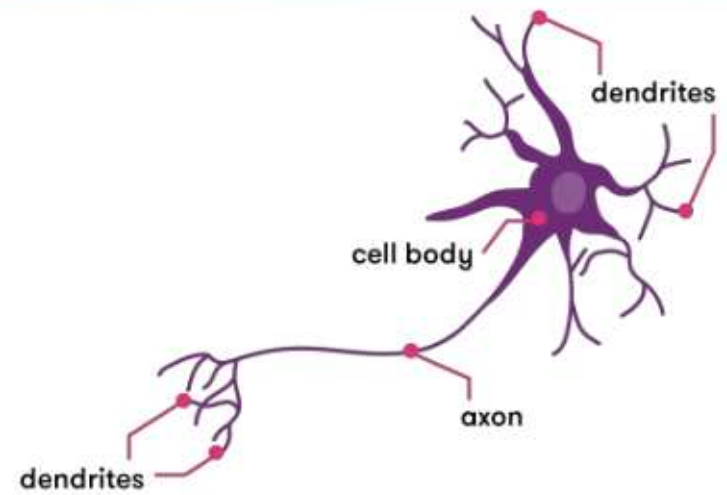
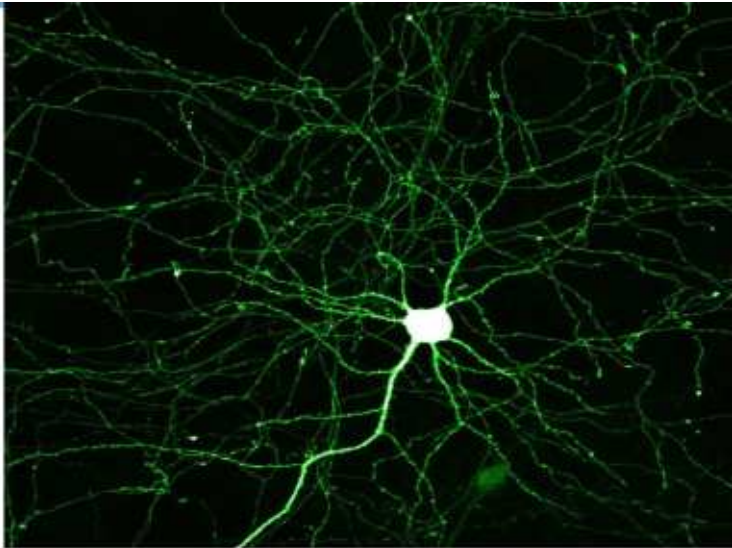
Nov 2022

Week 11: Agenda

- Biopotentials
- Electromagnetic Interference
- Noise
- Instrumentation Amplifier

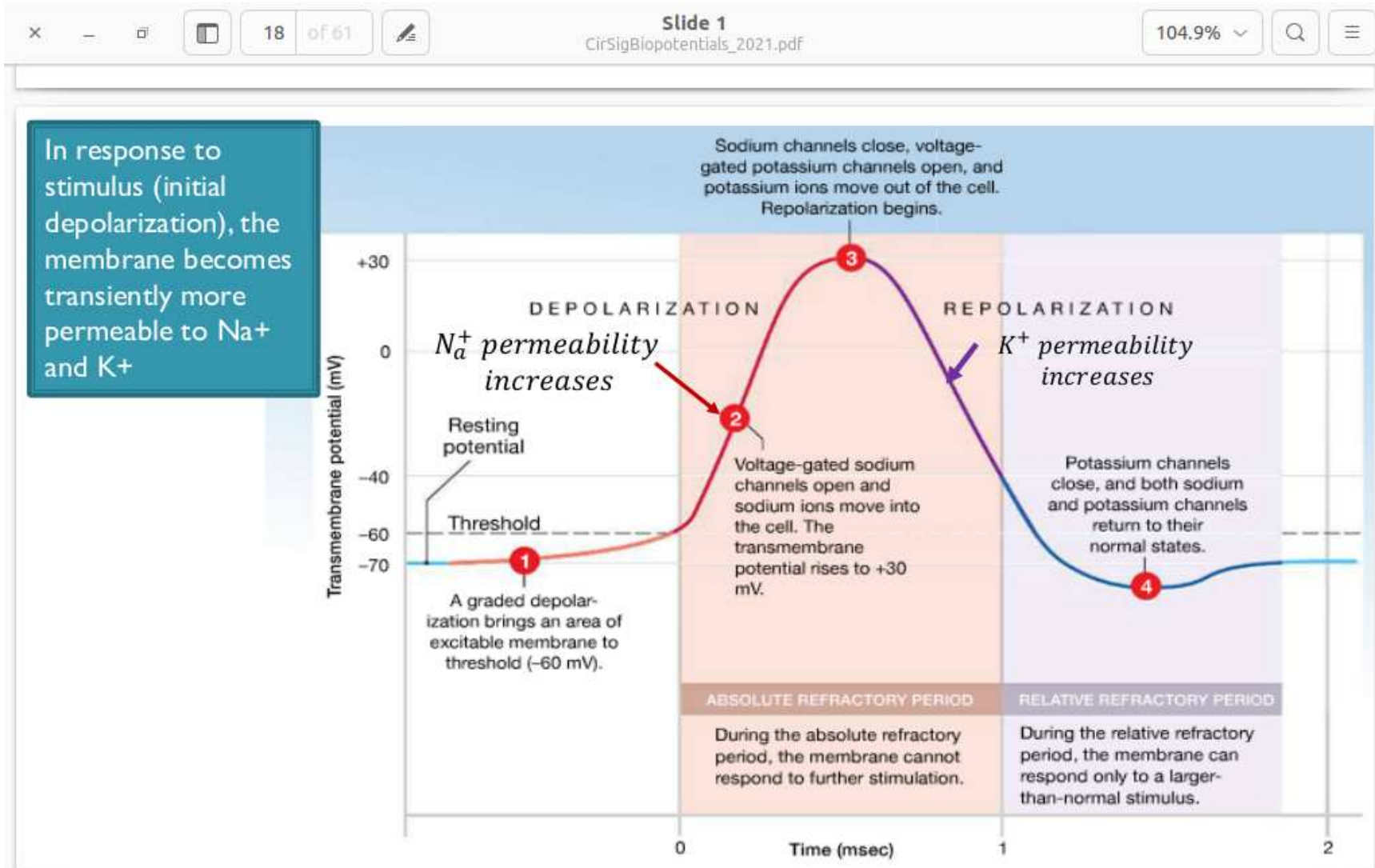
Biopotentials

Neuron



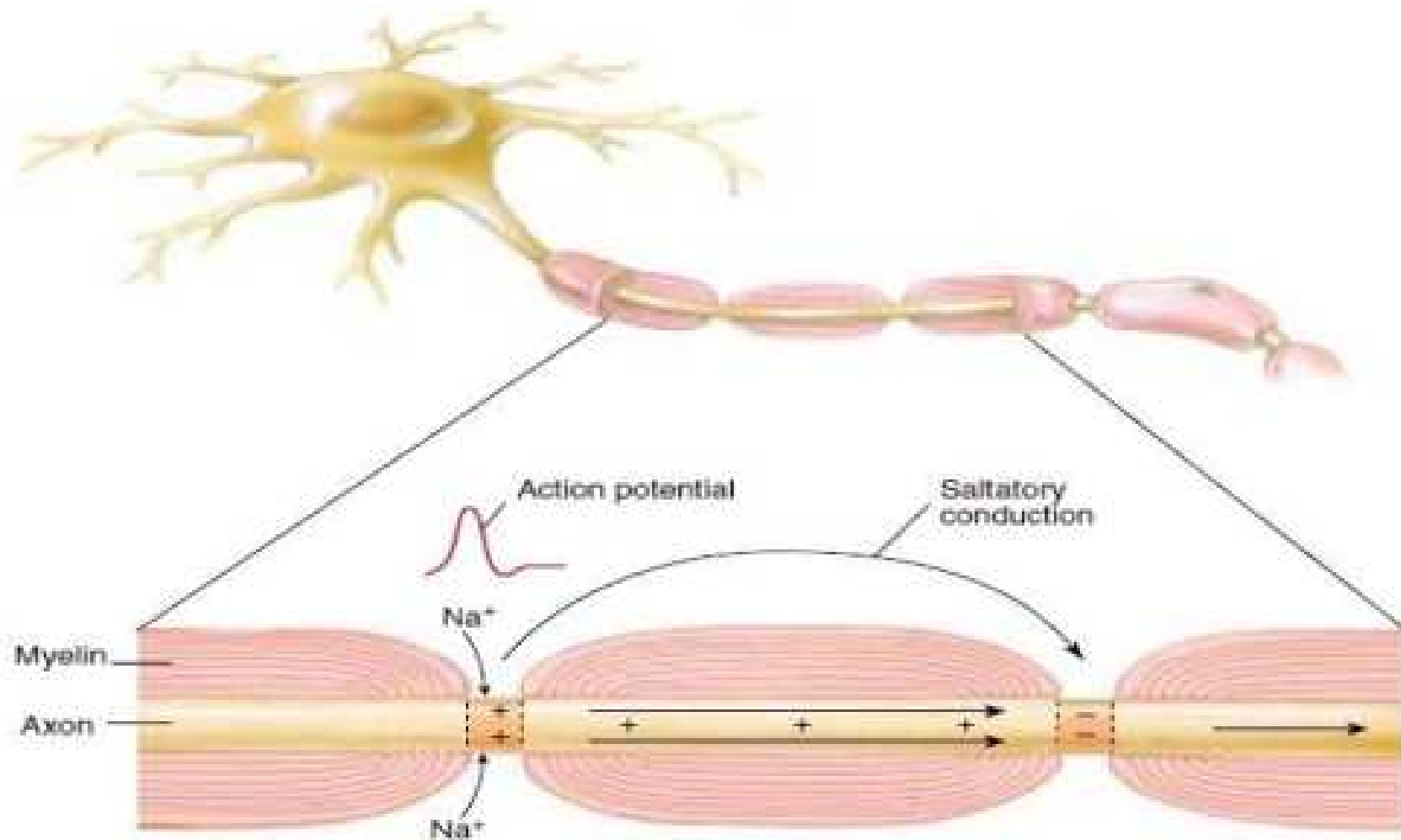
- Voltages from Ions: Na^+ , K^+ , Cl^-
- Typically mV
- Currents Flow for Signaling
- We Detect Voltages at Surface

Potential



Restoring the Membrane potential

Axon Current



Contributions to Signal

Measuring Electrical activity of the Heart (EKG)

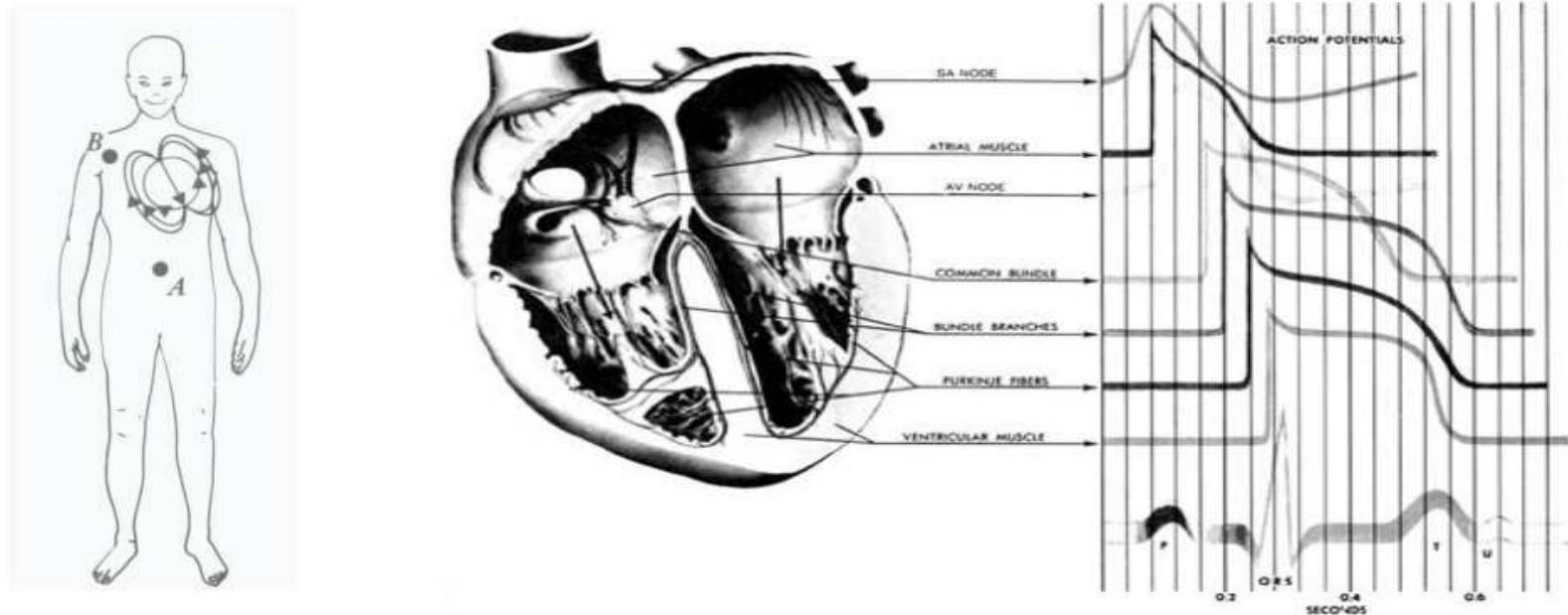
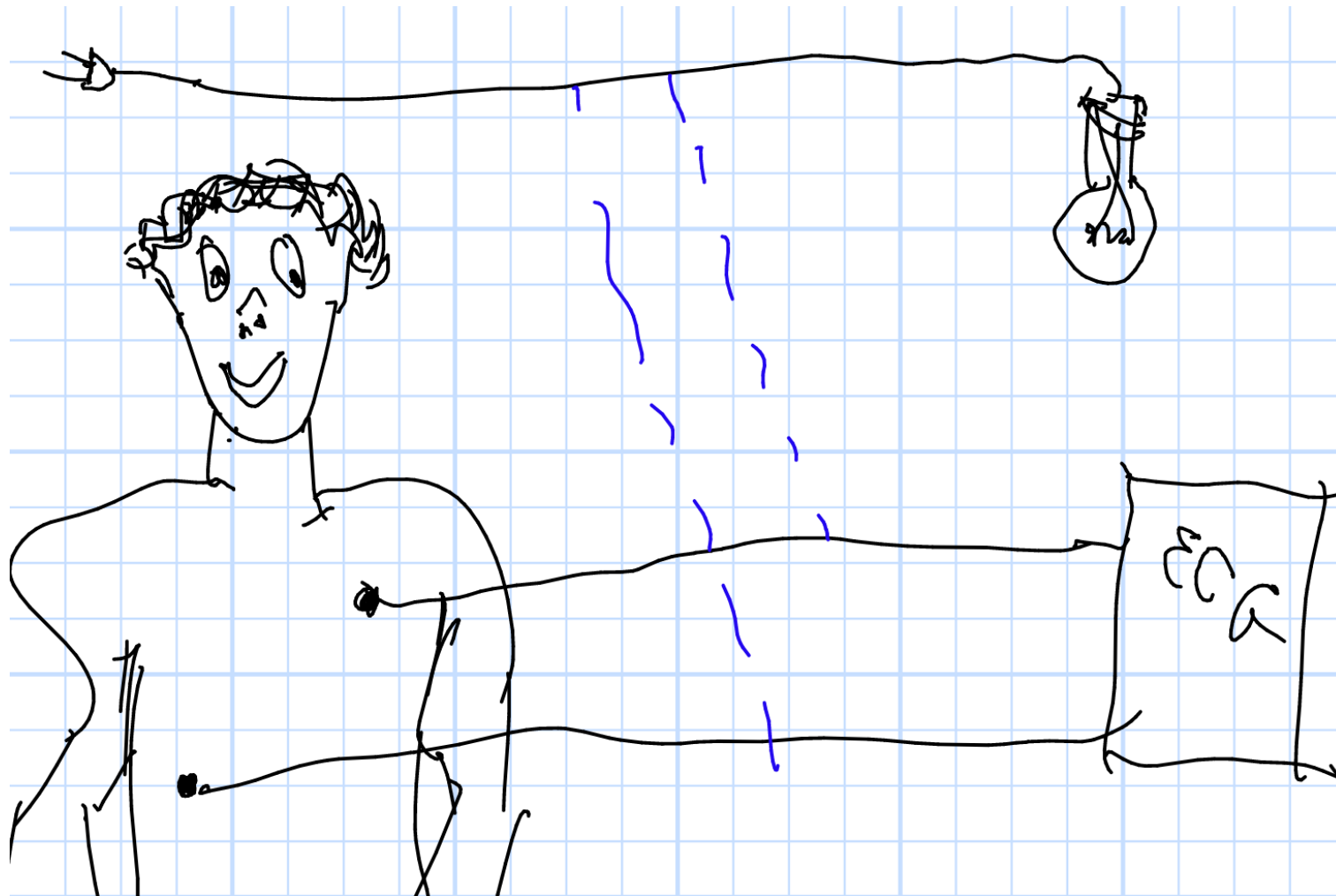


Figure 4.13 Representative electric activity from various regions of the heart. The bottom trace is a scalar ECG, which has a typical QRS amplitude of 1-3 mV. (© Copyright 1969 CIBA Pharmaceutical Company, Division of CIBAGEIGY Corp. Reproduced, with permission, from The Ciba Collection of Medical Illustrations, by Frank H. Netter, M. D. All rights reserved.)

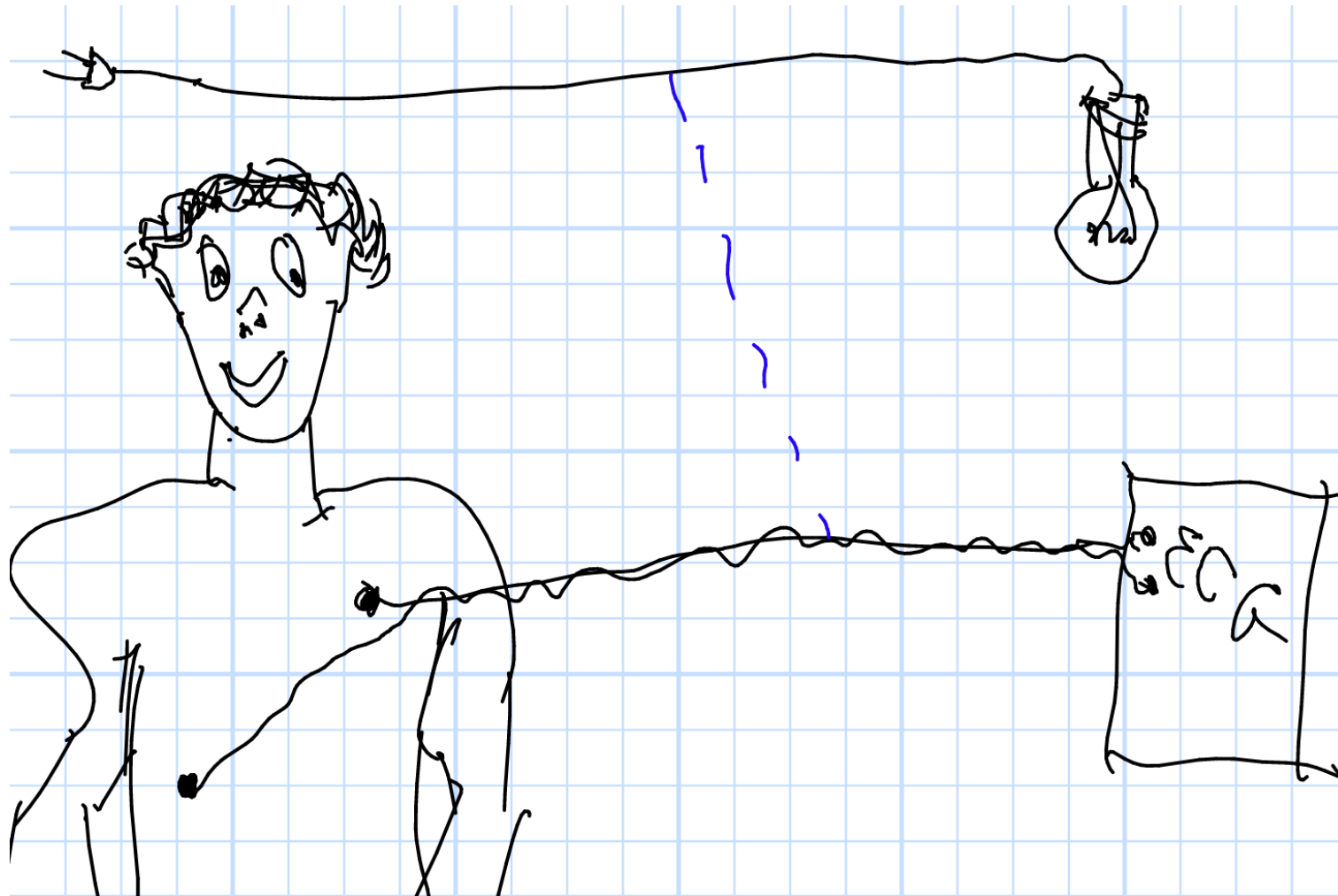
Typical Signals

- Millivolts
- Millisecond Features
- 1 Hz. Period (sort-of)
- Upper Right to Lower Left
- Noisy and Not Really Periodic

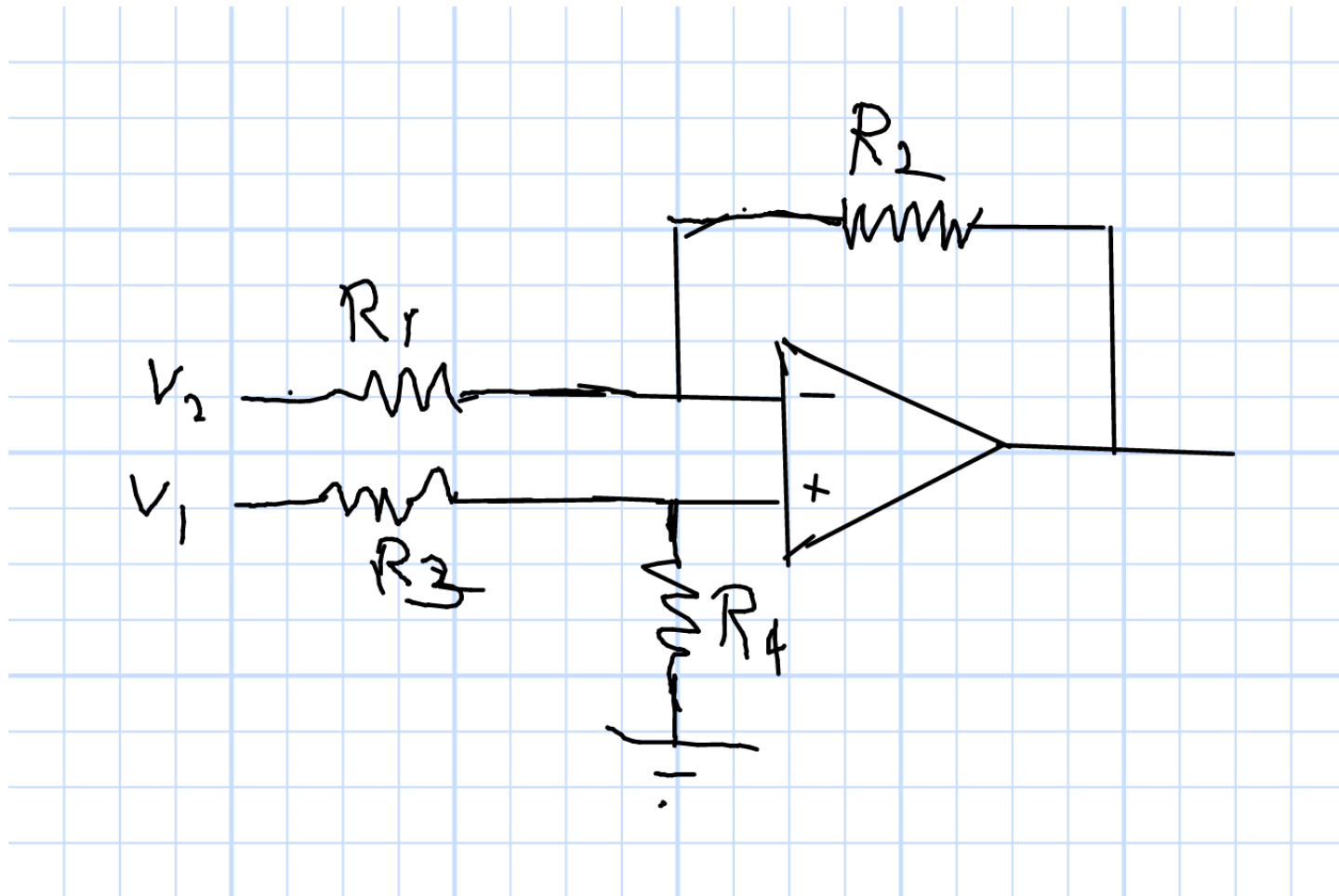
Electromagnetic Interference



Twisted Pair

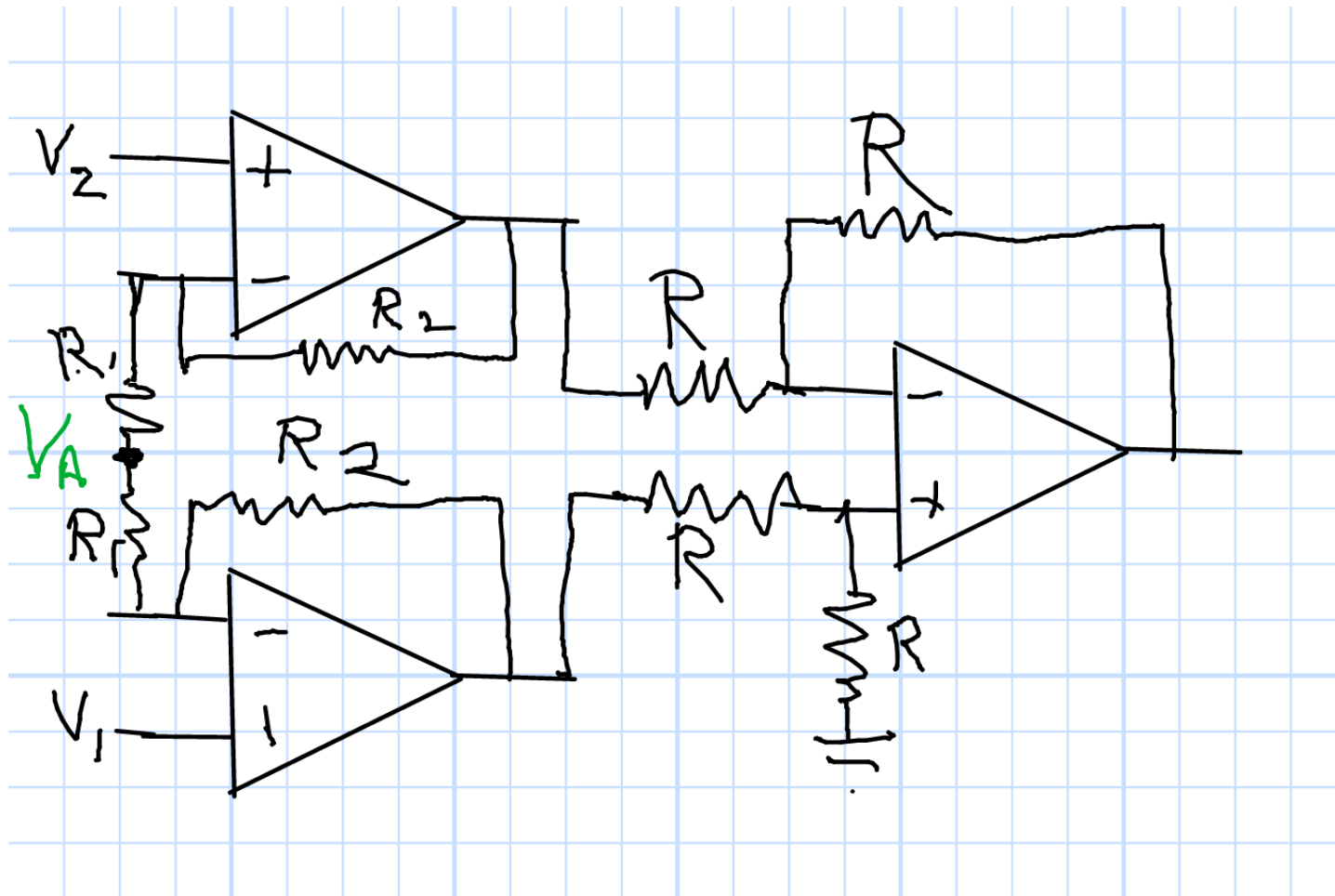


Differential Amplifier



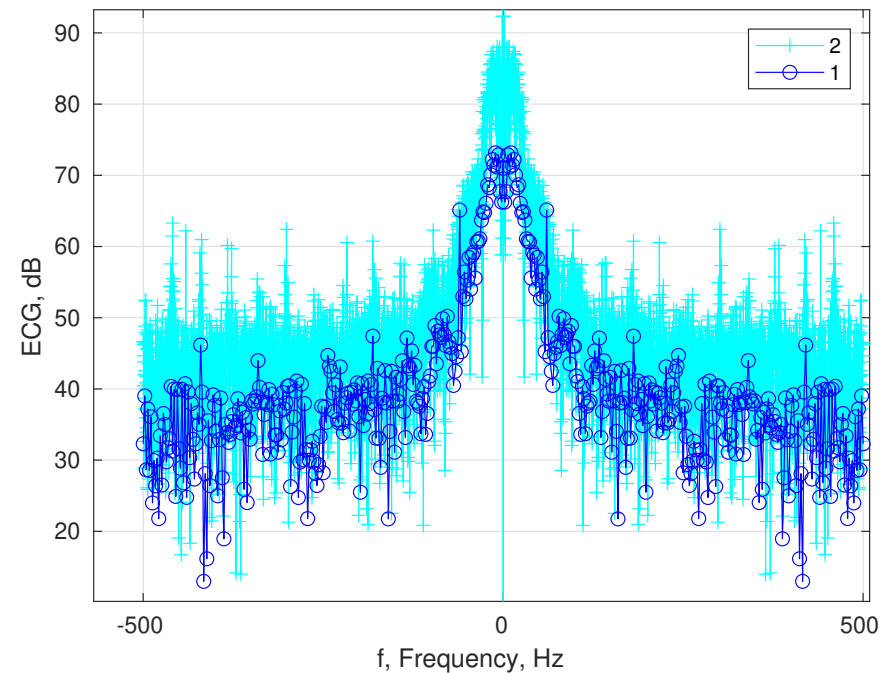
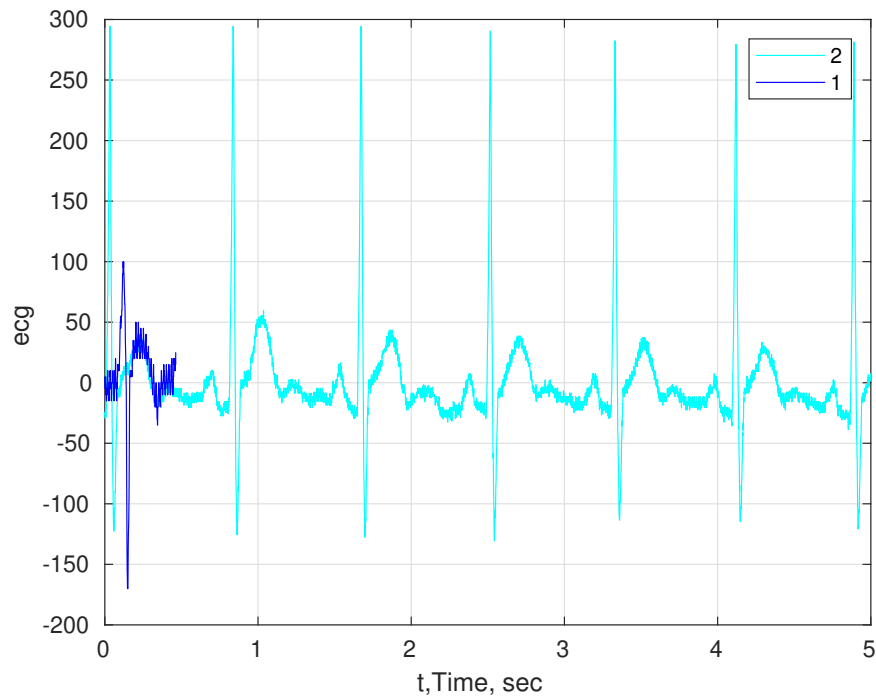
v_2 affects current in v_1 source (try superposition)

Good Differential Amplifier



Infinite input impedance. Low common-mode gain.

Exploring the Signal: Matlab Demo



- Sampling Frequency and Duration
- Bit Depth, Noise, DC, EMI
- Frequencies of Interest