Neuroprothetik Exercise 2
Mathematical Basics 1

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1 Plot slope fields and isoc lines

Plot the slope fields for t $\in [5, 5]$ and V $\in [5, 5]$ as well as the isoclines for $(-2, -1, 0, 1, 2)\frac{V}{s}$ for the following differential equations.

$$\frac{dV}{dt} = 1 - V - t \tag{1}$$

$$\frac{dV}{dt} = \sin t - \frac{1}{1.5}V \tag{2}$$

2 Differential equations of a simple cell model

Derive the differential equation corresponding to the integrate and fire neuron circuit, shown on the exercise sheet.

With

$$I_{ex} = I_R + I_c \tag{3}$$

and knowing that

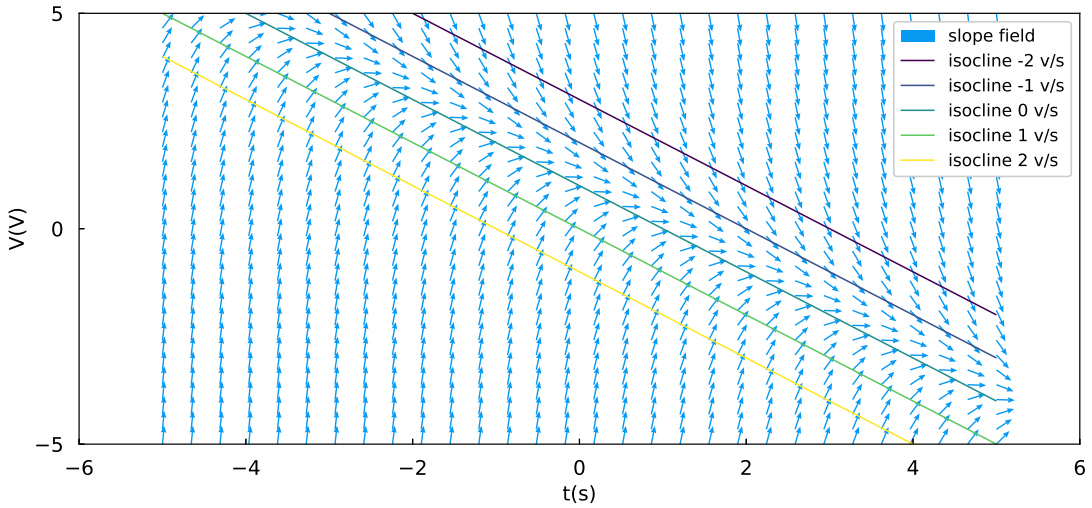
$$I_R = \frac{V}{R} \tag{4}$$

as well as

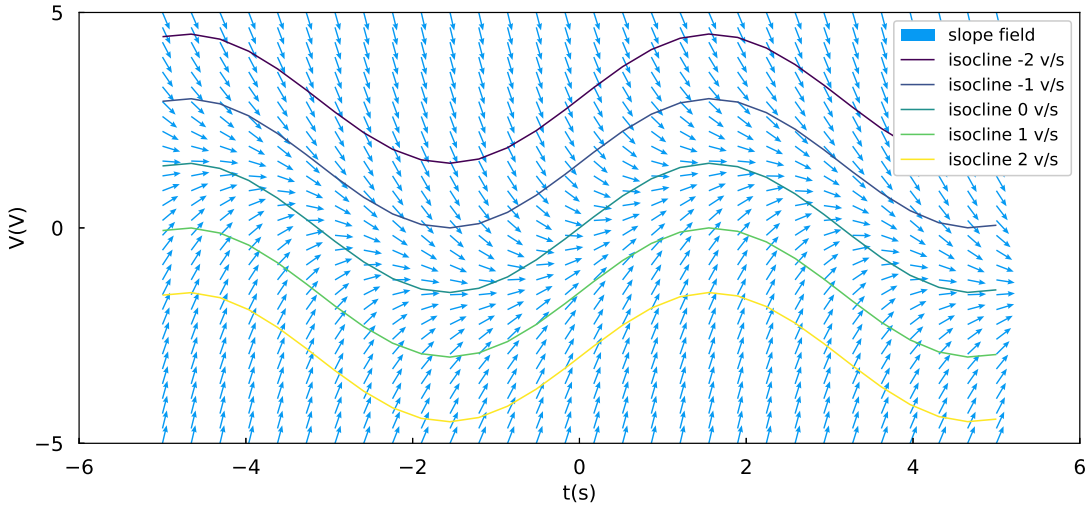
$$I_C = C * \frac{dV}{dt} \tag{5}$$

the differential equation can be derived as

$$\frac{dV}{dt} = \frac{I_{ex} - \frac{V}{R_i}}{C} = \frac{I_{max} * \sin t - \frac{V}{R_i}}{C} \tag{6}$$



(a)



(b)

Figure 1: Plot of slope field with isoclines for differential equations. Figure 1a for equation 1, figure 1b for equation 2 .

2.1 Plot the slope field

Plot the slope field for:

$$R_i = 1.3\Omega, C = 0.8F, I_{max} = 0A$$

and

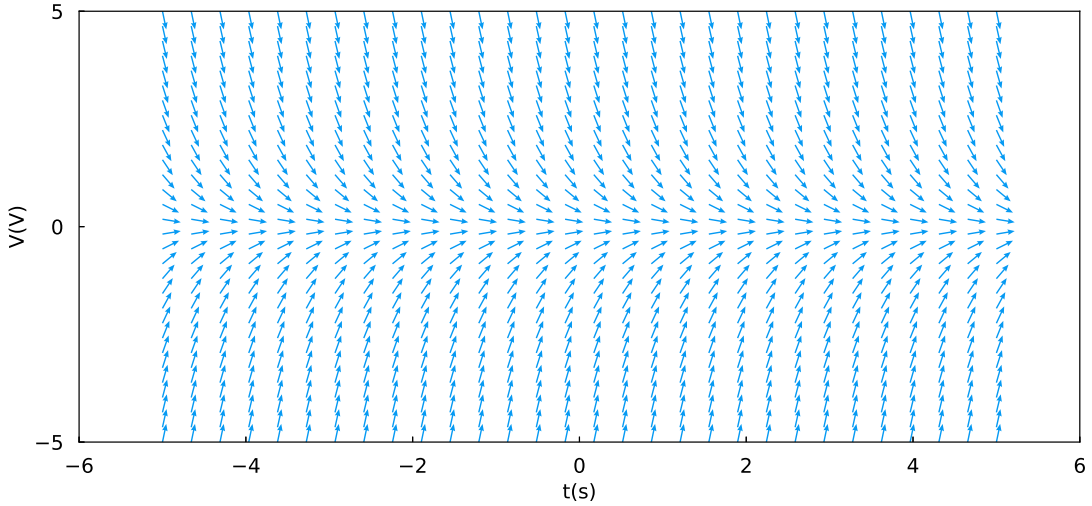
$$R_i = 1.3\Omega, C = 0.8F, I_{max} = 1A.$$

Add another constant term D=2 A to the current part of the differential equation and plot:

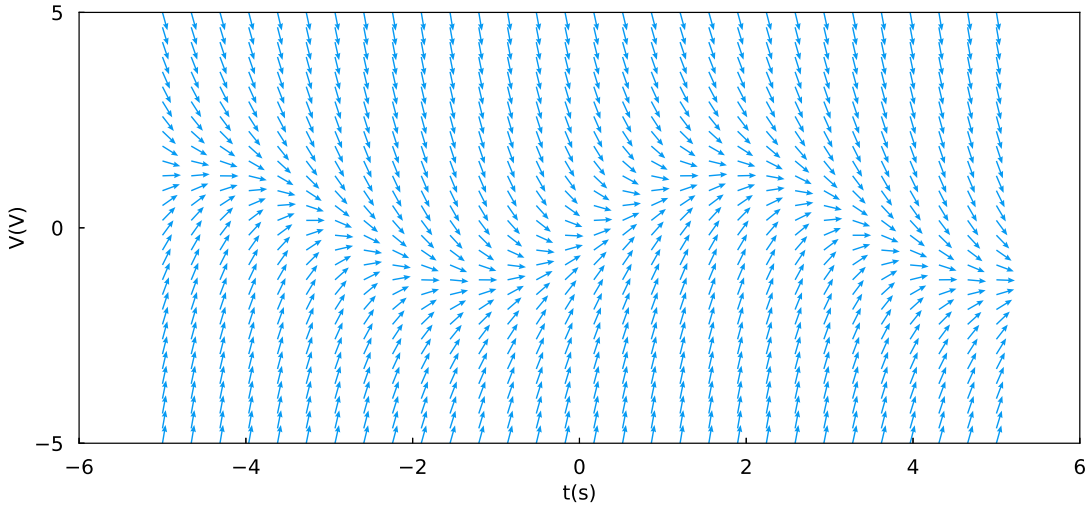
$$R_i = 1.3\Omega, C = 0.8F, I_{max} = 0A$$

and

$$R_i = 1.3\Omega, C = 0.8F, I_{max} = 1A.$$

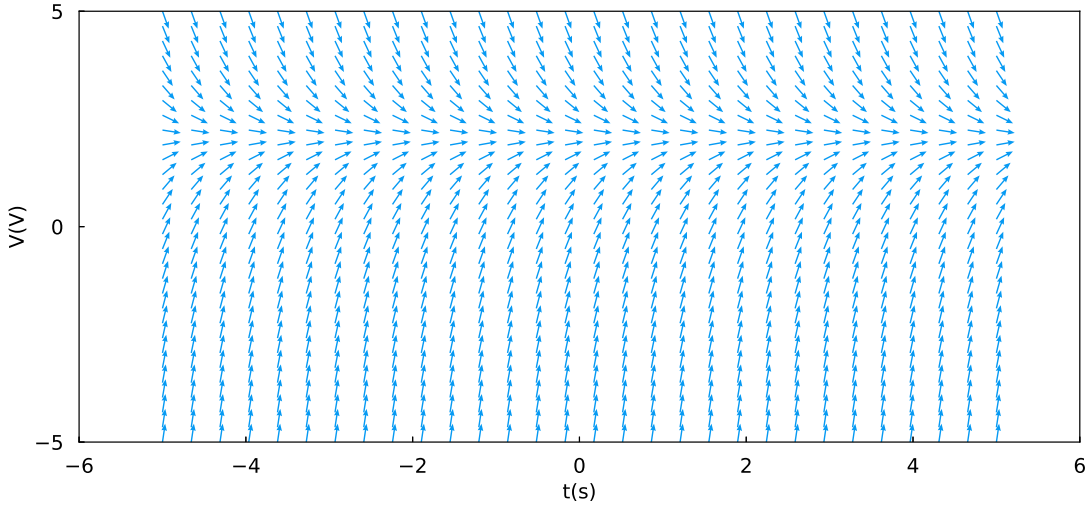


(a)

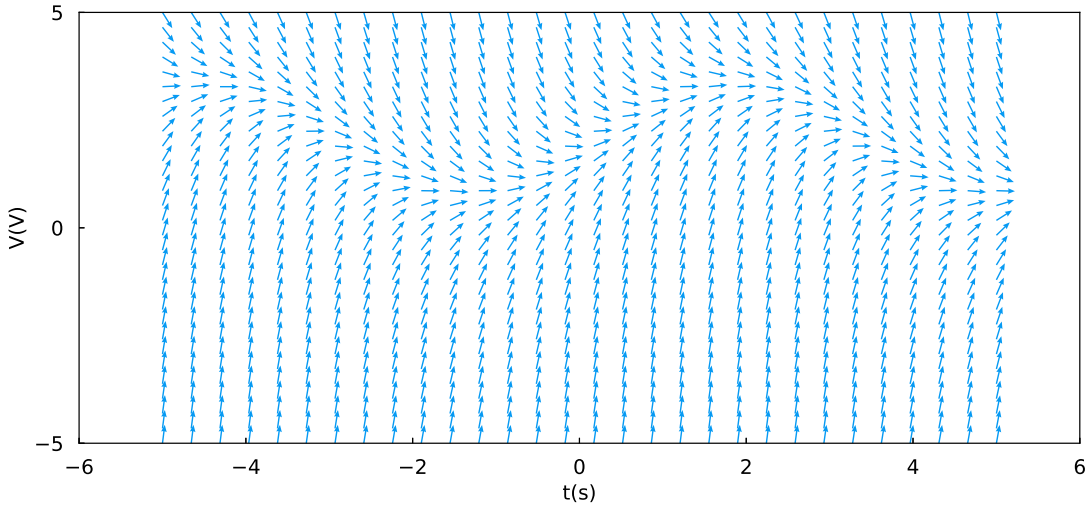


(b)

Figure 2: Plots of slope fields for the given leaky integrate and fire neuron circuit. Figure 2a for $R_i = 1.3\Omega$, $C = 0.8F$, $I_{max} = 0A$, figure 2b for parameter set $R_i = 1.3\Omega$, $C = 0.8F$, $I_{max} = 1A$.



(a)



(b)

Figure 3: Plots of slope fields for the given leaky integrate and fire neuron circuit with an additional constant D = 2. Figure 3a for $R_i = 1.3\Omega$, $C = 0.8F$, $I_{max} = 0A$, figure 3b for parameter set $R_i = 1.3\Omega$, $C = 0.8F$, $I_{max} = 1A$.