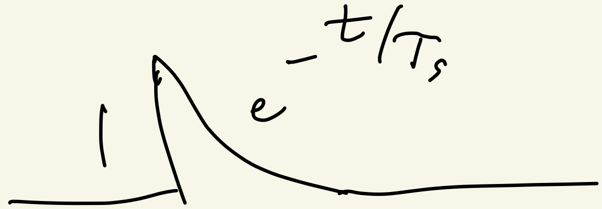


$$\tau_s \frac{ds}{dt} = -s$$

$$s \to s + 1$$

with

$$I = -\bar{g}_s s (V - E)$$

or

$$I = \bar{g}_s s$$

$$V = E + x$$

$$\tau \frac{dx}{dt} = -x + \bar{g}_s e^{-t/\tau_s} \qquad x(0) = 0$$

$$x = A e^{-t/\tau_s} + B e^{-t/\tau}$$

$$A = -B$$

$$x = A\left(e^{-t/\tau} - e^{-t/\tau_s}\right)$$

$$\tau \frac{dx}{dt} = -A e^{-t/\tau} + A \frac{\tau}{\tau_s} e^{-t/\tau_s}$$

$$= -A e^{-t/\tau} + A e^{-t/\tau_s} + \bar{g}_s e^{-t/\tau_s}$$

$$A\left(\frac{\tau}{\tau_s} - 1\right) = g_s = A\left(\frac{\tau - \tau_s}{\tau_s}\right)$$

$$A = \frac{g_s \tau_s}{\tau - \tau_s}$$

$$\boxed{\frac{g_s \tau_s}{\tau - \tau_s}\left(e^{-t/\tau} - e^{-t/\tau_s}\right)}$$

Average

etc

$$I_{max} = I_{min} + 1$$

$$I_{max}\, e^{-1/r\tau_s} = I_{min} = I_{max} - 1$$

$$\boxed{I_{max} = \frac{1}{1 - e^{-1/r\tau_s}}}$$

$$I = \frac{e^{-t/\tau_s}}{1 - e^{-1/r\tau_s}}$$

$$\bar{I} = r\int_0^{1/r} dt \; \frac{e^{-t/\tau_s}}{1 - e^{-1/r\tau_s}}$$

$$= r\tau_s \, \frac{1 - e^{-1/r\tau_s}}{1 - e^{-1/r\tau_s}} = \tau_s r$$

$$\boxed{\bar{I} = \bar{g}_s r \tau_s}$$

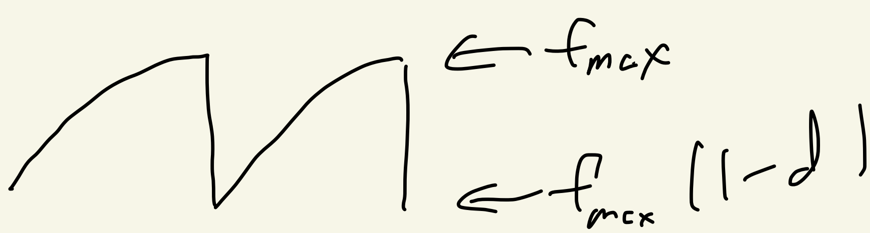
Short-term depression

$$I_s = \bar{g}_s s f$$

$$\tau_d \frac{df}{dt} = 1 - f \, ,$$

on presynaptic spike $\quad f \rightarrow (1-d) f$

steady spikes at rate r



$$1 + \left((1-d) f_{max} - 1\right) e^{-1/r\tau_d} = f_{max}$$

$$1 - e^{-1/r\tau_d} = f_{max} - (1-d) f_{max} e^{-1/r\tau_d}$$

$$f_{max} = \frac{1 - e^{-1/r T_d}}{1 - (1-d)\, e^{-1/r T_d}}$$

$$r >> T_d$$

$$f_{max} \rightarrow \frac{1/r T_d}{d}$$

$$f_{max} = \frac{1}{d r T_d} \sim \frac{1}{r}$$