

### Question 3: LIF Firing Rate

[3 marks]

Recall that the sub-threshold membrane potential for a LIF neuron is governed by the DE,

$$\tau \frac{dv}{dt} = v_{\text{in}} - v. \quad (1)$$

Show that if  $v_{\text{in}}$  is held constant, then the firing rate of a LIF neuron can be computed using

$$G(v_{\text{in}}) = \begin{cases} \frac{1}{\tau_{\text{ref}} - \tau \ln\left(1 - \frac{1}{v_{\text{in}}}\right)} & \text{for } v_{\text{in}} > 1 \\ 0 & \text{otherwise} \end{cases}$$

*Hint:* The time between spikes ( $t_{\text{isi}}$ , the “inter-spike interval”) is the reciprocal of the firing rate, and is also the sum of the refractory time and the time it takes for  $v$  to climb from 0 to the threshold of 1.