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First passage time distribution for spiking neuron with fast inhibitory feedback stimulated with renewal stream

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We consider a class of spiking neuron models defined by a set of conditions typical for basic threshold-type models, such as leaky integrate-and-fire model and some artificial neurons. A series of impulses, representing a point renewal process, is applied to a neuron. Each output impulse is fed back to the neuron after a fixed time delay, Δ. This impulse acts as an impulse received through a fast inhibitory ($GABA_a$) synapse.
In our previous work [1], we have obtained a general relation in case of input Poisson stream for calculating exactly the probability density function (PDF) $p(t)$ for the distribution of the first passage time of crossing the threshold.
In the present work, we have obtained a similar results but applicable in case of any renewal input stream. The calculation is based on the known PDF $p^0(t)$ for the same neuron without feedback and the PDF of interspike intervals for input stream, $p^{in}(t)$.

[1]. Vidybida, A., Shchur, O. Relation between firing statistics of spiking neuron with delayed fast inhibitory feedback and without feedback, *Fluctuation and Noise Letters*, 17(01):1850005 (2018).

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