D26 (HW 2005 11.3)

$t = \frac{\tau}{T}$ = transmittion prob.

response time (τ)

av. time between emmiting (T)

$I_i = \frac{e}{\tau} n_i$

a) $\langle I \rangle = \frac{e}{\tau}\langle n_i \rangle$, $\langle n_i \rangle = \frac{\tau}{T}$, $\boxed{\langle I \rangle = \frac{e}{T}}$

$$\langle (I - \langle I \rangle)^2 \rangle = \frac{e^2}{\tau^2}\langle n_i^2 \rangle - \langle I \rangle^2$$

but for $n_i = 0, 1$, $n_i^2 = n_i$, $\langle n_i^2 \rangle = \langle n_i \rangle = \frac{\tau}{T}$

$$\langle \delta I^2 \rangle = \frac{e^2}{\tau^2} \cdot \frac{\tau}{T} - \frac{e^2}{T^2} = \frac{e^2}{\tau^2} t(1-t)$$

e^- פולסים של $T \to \infty$ "   השני: כל הזמן עובר זרם "

if $t = 0$ or $t = 1$ we have $\langle \delta I^2 \rangle = 0$

בשני המקרים מאבדים את האופי הבדיד של האלקטרונים.

b) for $t \ll 1$ $\langle \delta I^2 \rangle \approx \frac{e^2}{\tau^2} t = \frac{e^2}{\tau^2} \cdot \frac{\tau}{T} = \frac{e}{\tau} \cdot \frac{e}{T} = \frac{e}{\tau}\langle I \rangle$

in freq. interval $\left[\frac{1}{\tau}, \frac{1}{\tau} + d\left(\frac{1}{\tau}\right)\right]$ we have $\left[\frac{\omega}{2\pi}, \frac{(\omega + d\omega)}{2\pi}\right]$

$$d\langle \delta I^2 \rangle = e\langle I \rangle \cdot \frac{d\omega}{2\pi}$$

Johnson noise: $d\langle \delta I^2 \rangle = \frac{2kT}{\pi R} d\omega$ (see HW 10.4)

Shot noise: $d\langle \delta I^2 \rangle = e\langle I \rangle \frac{d\omega}{2\pi}$

Shot noise dominates: $\rightarrow$ Shot >> Johnson $\rightarrow$ $\underbrace{kT \ll \frac{e\langle I \rangle R}{4} = \frac{1}{4} e\langle V \rangle}$

c) $\langle I^3 \rangle = \left(\frac{e}{\tau}\right)^3 \frac{\tau}{T} = \frac{e^2}{\tau^2}\langle I \rangle$

$$\langle (I - \langle I \rangle)^3 \rangle = \langle I^3 \rangle - 3\langle I^2 \rangle \langle I \rangle + 3\langle I \rangle^3 - \langle I \rangle^3$$

$$= \frac{e^2}{\tau^2}\langle I \rangle - 3\frac{e^2}{\tau^2}\langle I \rangle^2 + 2\langle I \rangle^3$$

$$= \frac{e^3}{\tau^3}\left(t - 3t^2 + 2t^3\right) = \frac{e^3}{\tau^3} t(1-t)(1-2t)$$