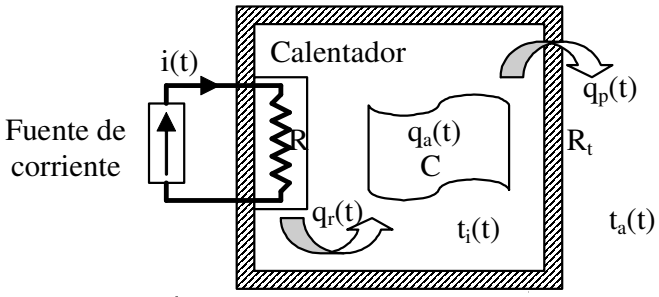
El sistema de la figura se modela mediante las ecuaciones:

$q_r(t)=q_a(t)+q_p(t)$
$q_r(t)=R\cdot i^2(t)$
$q_a(t)=C\cdot dt_i(t)/dt$
$q_p(t)=(t_i(t)-t_a(t))/R_t$

Con los siguientes valores de los parámetros:

R=20 Ω; C=4184 julio/ºC; Rt=0.1 ºC·s/julio

Obtener las funciones de transferencia "$T_i(s)/I(s)$" y " $T_i(s)/T_a(s)$", para el punto de funcionamiento dado por "$i_0=0.5$ A" y "$t_{a0}=19$ ºC".



a) Pto de funcionamiento:

$q_{ro} = q_{ao} + q_{po}$
$q_{ro} = R\, i_o^2$
$q_{ao} = 0$
$q_{po} = (t_{io} - t_{ao})/R_T$

$i_o = 0{,}5$ $\quad q_{ro} = q_{po} = 20 \cdot 0{,}25 = 5$
$t_{ao} = 19$
$R\, R_T\, i_o^2 = t_{io} - t_{ao}$
$20 \cdot 0{,}1 \cdot 0{,}25 = t_{io} - 19 \Rightarrow t_{io} = 19{,}5$

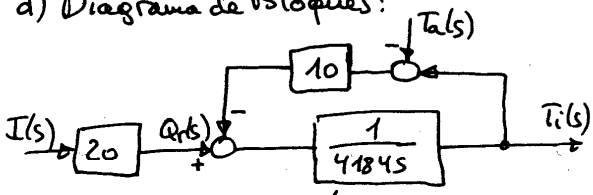
b) Linealización:

$\Delta q_r(t) = \Delta q_a(t) + \Delta q_p(t)$
$\Delta q_r(t) = 2R\, i_o\, \Delta i(t) = 20\, \Delta i(t)$
$\Delta q_a(t) = C \dfrac{d\Delta t_i(t)}{dt} = 4184 \dfrac{d\Delta t_i(t)}{dt}$
$\Delta q_p(t) = 10\,(\Delta t_i(t) - \Delta t_a(t))$

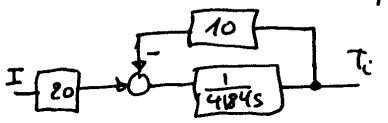
c) Transformada de Laplace:

$Q_r(s) = Q_a(s) + Q_p(s)$
$Q_r(s) = 20\, I(s)$
$Q_a(s) = 4184 \cdot s \cdot T_i(s)$
$Q_p(s) = 10\,(T_i(s) - T_a(s))$

d) Diagrama de Bloques:



e) FT $T_i(s)/I(s) = \dfrac{2}{418{,}45s+1}$



f) FT $T_i(s)/T_a(s) = \dfrac{1}{418{,}45s+1}$