

Inngående stråling: $\pi R^2 S$

Utgående stråling: σT^4 per kvadratmeter.

T temperatur i Kelvin

$$\sigma = 5.67 \cdot 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$$

Total utgående stråling: $4\pi R^2 \sigma T^4$

Likelsehl når: $\cancel{\pi R^2} S = 4\cancel{\pi R^2} \sigma T^4$

$$S = 4\sigma T^4$$

$$T = \left(\frac{S}{4\sigma} \right)^{1/4} = \left(\frac{Q}{\sigma} \right)^{1/4} \quad \text{der } Q = \frac{S}{4}.$$

Sått inn:

$$T = \left(\frac{\frac{1}{4} \cdot 1376.6}{5.67 \cdot 10^{-8}} \right)^{1/4} \approx 278.7 \text{ K} \approx \underline{5.5^\circ \text{C}}$$

"Riktig svar" $\approx 16^\circ \text{C}$

Tar hensyn til albedo:

α Andelen af solenergien som reflekteres

Målt $\alpha = 0.3$ (i gennemsnit).

Ny indkommende energi: $\pi R^2 S (1 - \alpha)$

Utgående (som før) $4\pi R^2 \sigma T^4$

Balance: ~~$\pi R^2 S (1 - \alpha) = 4\pi R^2 \sigma T^4$~~

$$T = \left(\frac{S(1-\alpha)}{4\sigma} \right)^{1/4} \approx 254.9 \text{ K} \approx \underline{\underline{-19^\circ\text{C}}}$$

Tar hensyn til drivhuseffekten:

Utgående energi: $4\pi R^2 \epsilon \sigma T^4$ der $0 < \epsilon < 1$

Settes $\epsilon = 0.66$ gir

Balance

$$\pi R^2 S (1 - \alpha) = 4\pi R^2 \epsilon \sigma T^4$$

$$T = \left(\frac{S(1-\alpha)}{4\epsilon\sigma} \right)^{1/4}$$

$$\epsilon = 0.66 \text{ gir } T = 288 \text{ K}$$

Differentialgleichung

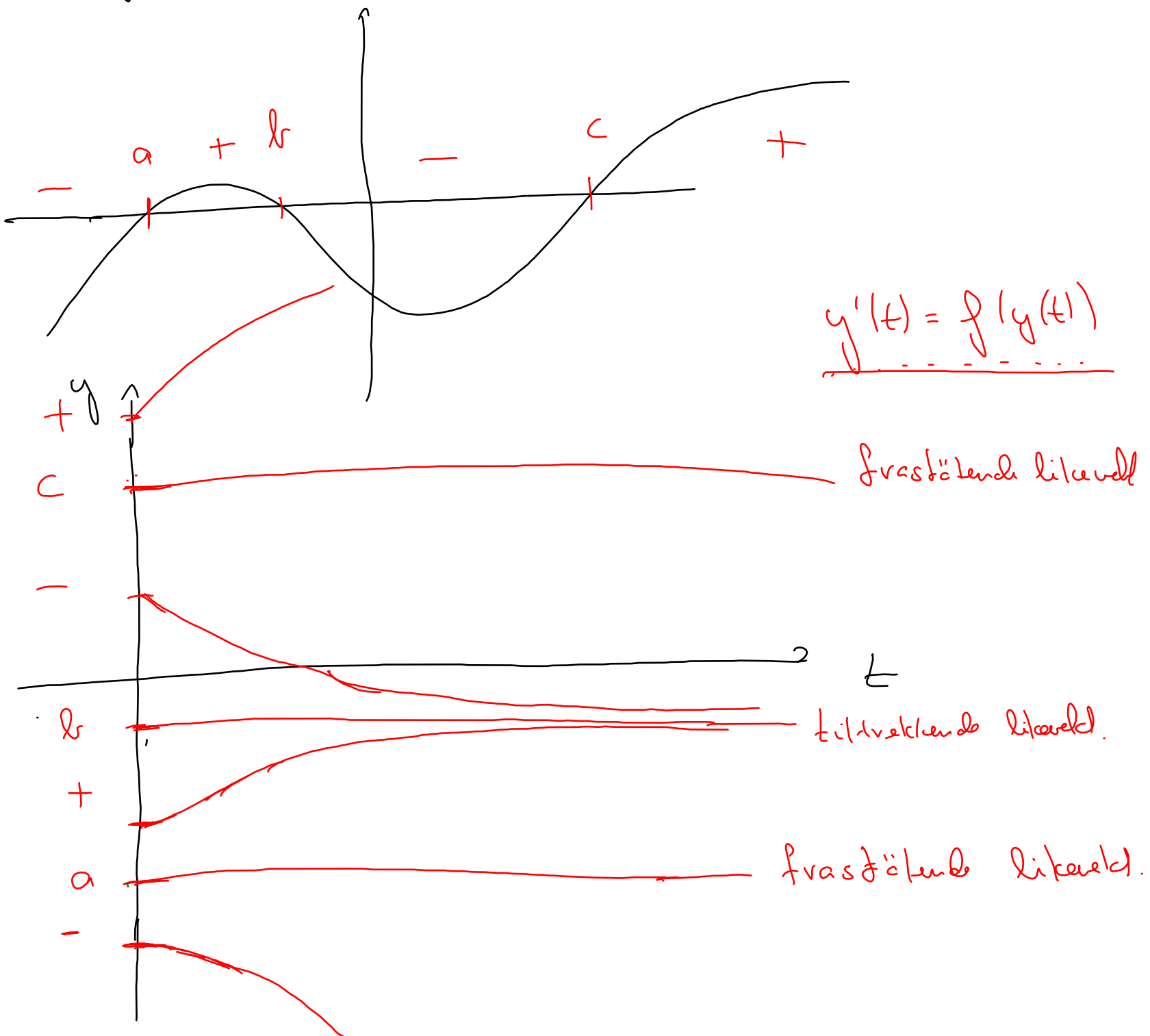
Generell: $y'(t) = f(t, y(t))$ $y(0) = y_0$

Autonome system:

$$y'(t) = f(y(t)) \quad y(0) = y_0$$

Graphisch Lösung:

Lager feldquerschnitt für f



Tilbage til klimamodellene

$T(t)$ temperatur ved tiden t :

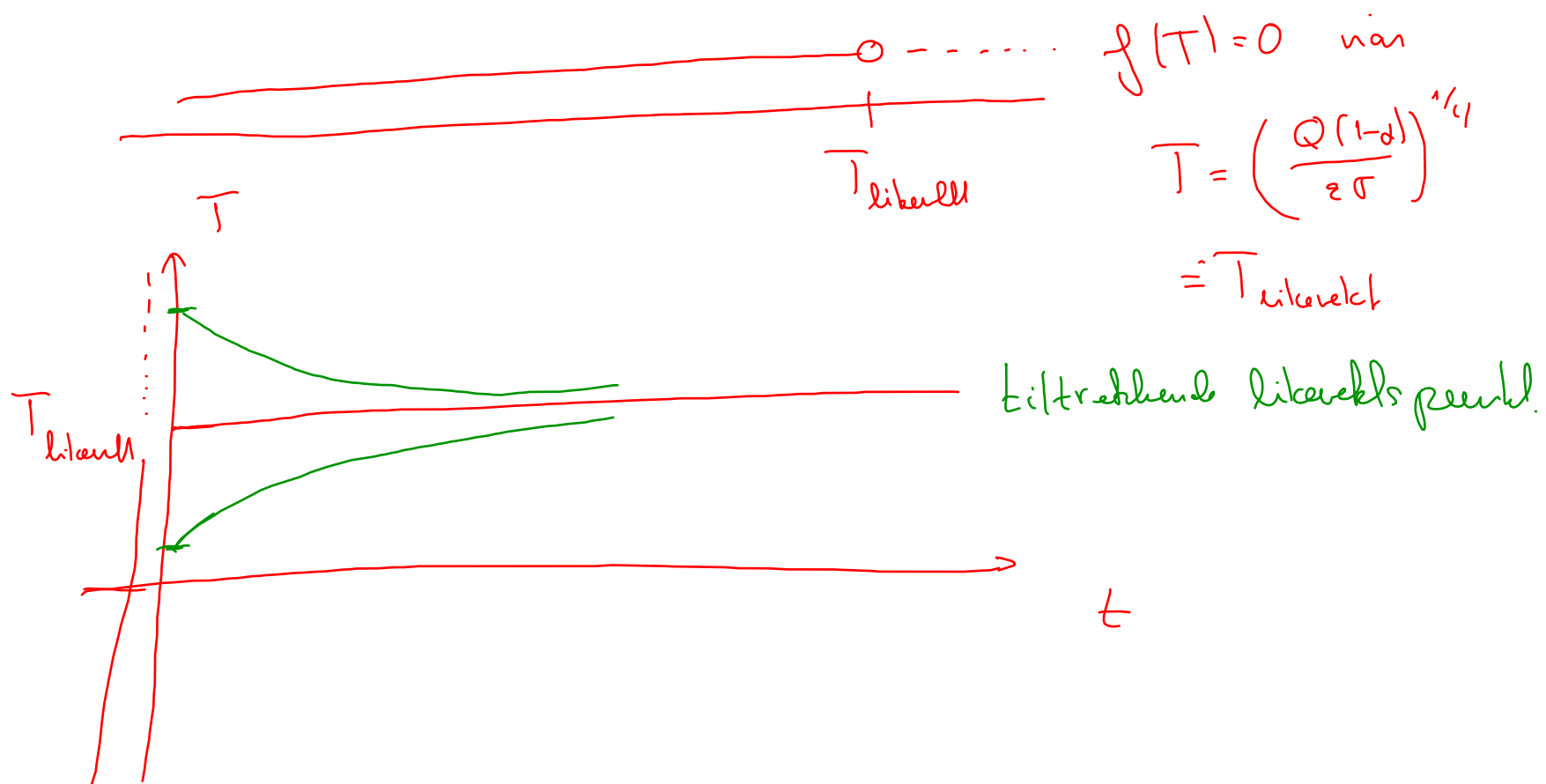
Omtrent: $T'(t) = k (E_{\text{inn}} - E_{\text{ut}})$

$$= k (\pi R^2 S (1 - \alpha) - 4 \pi R^2 \epsilon \sigma T^4)$$

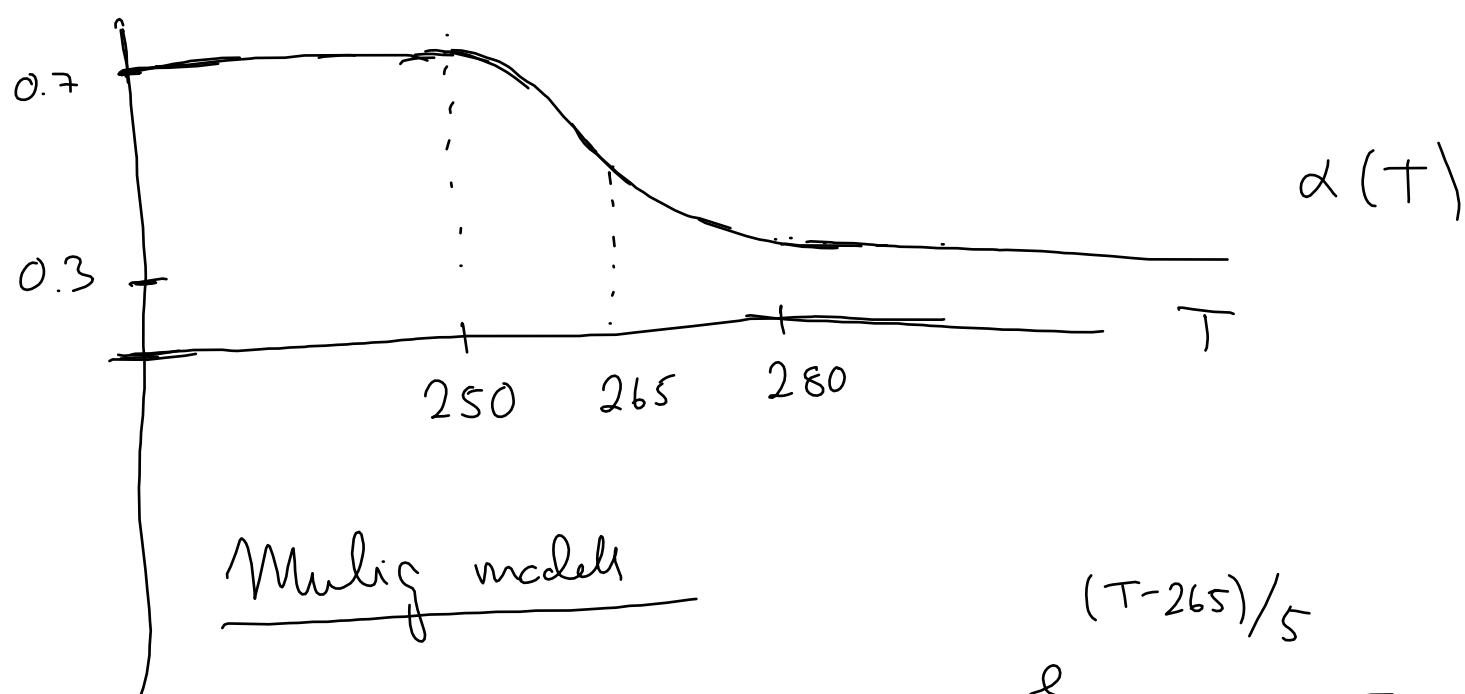
$$= \underbrace{4 \pi R^2 k}_{C} \left[\frac{S}{4} (1 - \alpha) - \epsilon \sigma T^4 \right]$$

$$= C [Q (1 - \alpha) - \epsilon \sigma T^4]$$

altså $T'(t) = C [Q (1 - \alpha) - \epsilon \sigma T^4]$, $f(T) = C [Q (1 - \alpha) - \epsilon \sigma T^4]$



Men albedoen avh nger  pp  av T (mer is, st rre albedo)

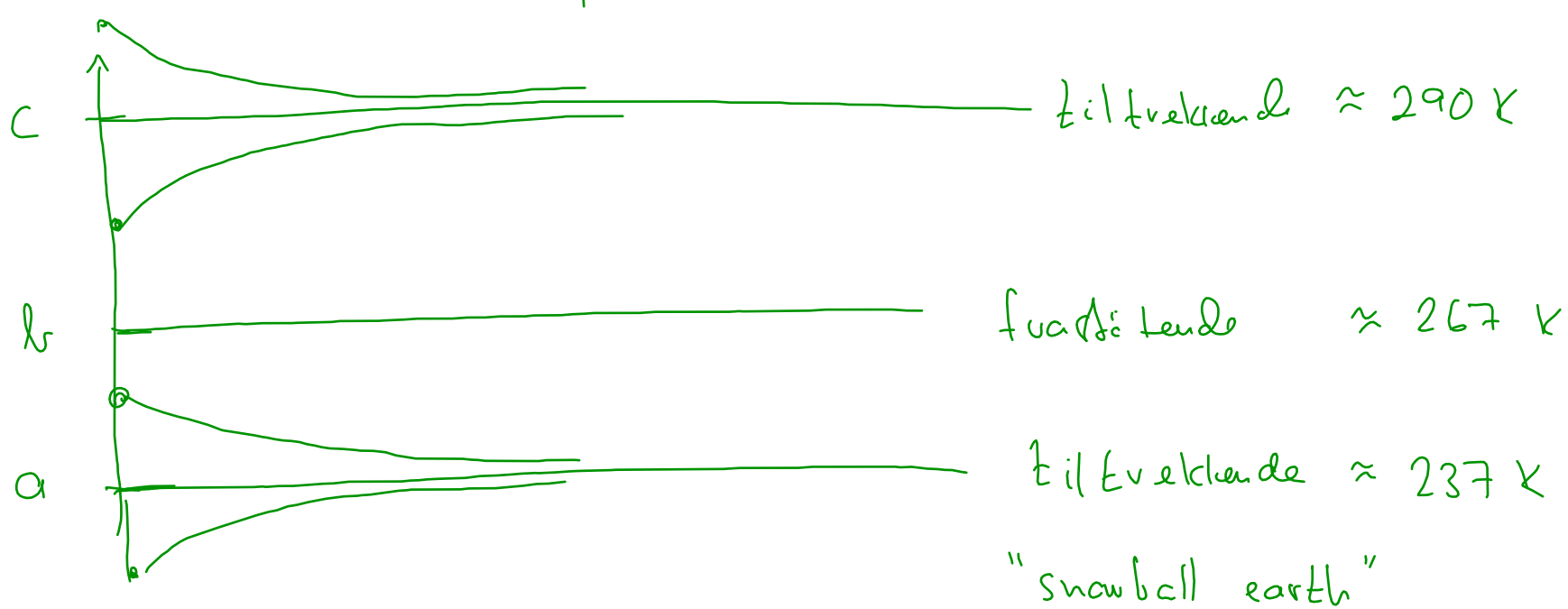
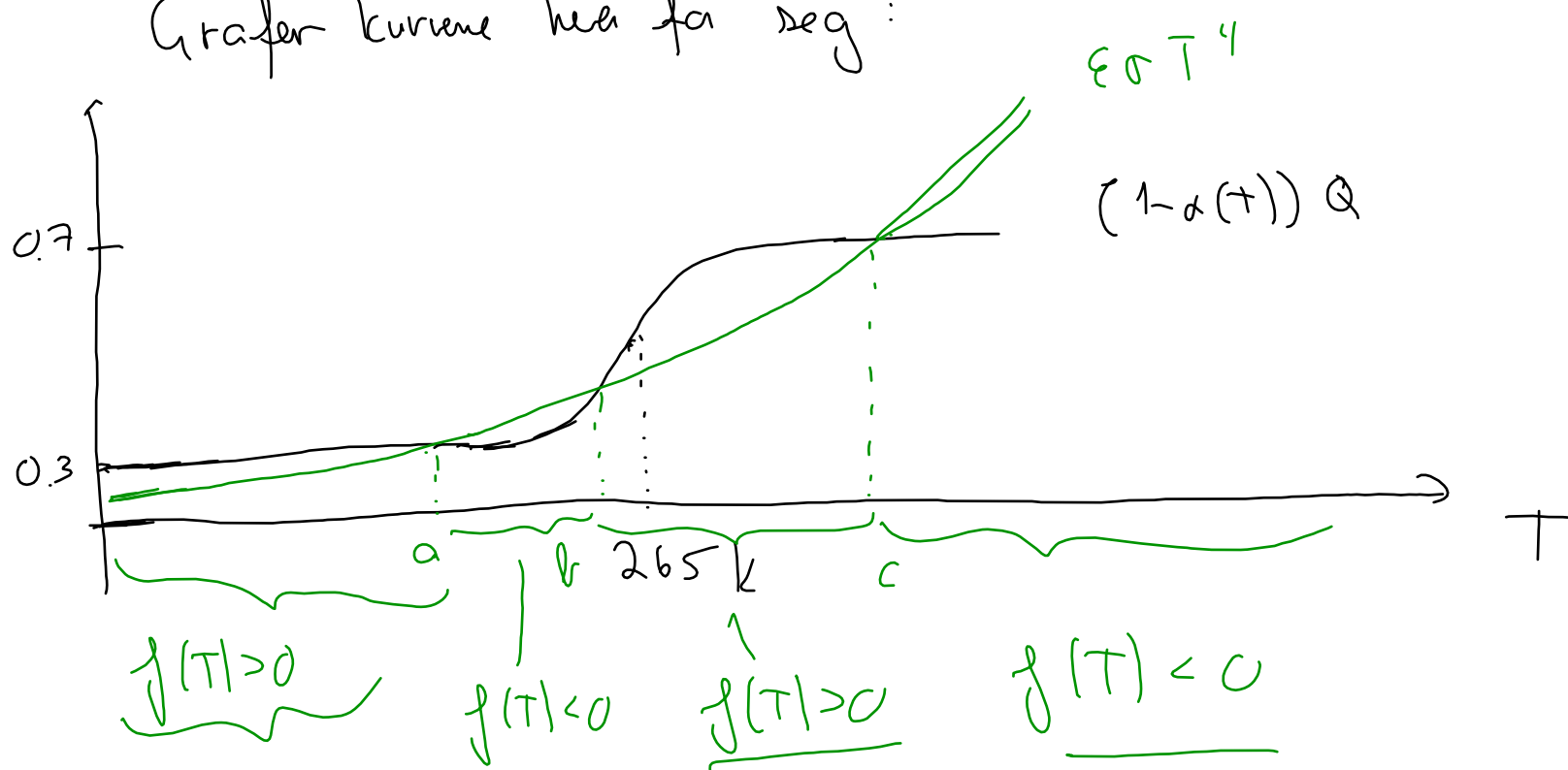


$$\alpha(T) = 0.7 - 0.4 \frac{e^{(T-265)/5}}{1 + e^{(T-265)/5}}$$

Dynamisk modell

$$T'(t) = C \underbrace{[(1 - \alpha(T))Q - \epsilon \sigma T^4]}_{f(T)}$$

Grafen kurven har f r sig:



 ndringer

