2.1 (a)

$$\begin{cases} u_1(t) + C_2R_2\dfrac{du_2(t)}{dt} + u_2(t) = v(t). \\ C_1\dfrac{du_1(t)}{dt} + \dfrac{u_1(t)}{R_1} = C_2\dfrac{du_2(t)}{dt} \end{cases}$$

$$\Rightarrow \quad C_1C_2R_1R_2\frac{d^2u_2(t)}{dt^2} + (C_1R_1 + C_2R_2 + C_2R_1)\frac{du_2(t)}{dt} + u_2(t) = C_1R_1\frac{dv(t)}{dt} + v(t).$$

(b)

$$u_3(t) = u_2(t) + C_2R_2\frac{du_2(t)}{dt}$$

与(a)结果联立 $C_1C_2R_1R_2\dfrac{d^2u_3(t)}{dt^2} + (C_1R_1 + C_2R_2 + C_2R_1)\dfrac{du_3(t)}{dt} + u_3(t) = C_1R_1C_2R_2\dfrac{d^2v(t)}{dt^2} + (C_1R_1 + C_2R_2)\dfrac{dv(t)}{dt} + v(t)$

(c)

$$0.25\frac{d^2u_2(t)}{dt} + 1.5\frac{du_2(t)}{dt} + u_2(t) = \frac{dv(t)}{dt} + v(t).$$

2.7

$$\begin{cases} 2sx + x - sf - f = 0 \\ 4sy + y - 2sz - z = 0 \\ 3sz - x + z = 0 \end{cases}$$

联立得 $4sy + y = \dfrac{s+1}{3s+1}f$

$$12\frac{d^2y}{dt^2} + 7\frac{dy}{dt} + y = \frac{df}{dt} + f.$$

2.8 (a) 设兔数为 $r(m)$，狼数为 $w(m)$.

$$r(m+1)=(1+a)r(m)-\lambda w(m)$$

$$w(m+1)=\left[k\frac{r(m)-\lambda w(m)}{w(m)}+\gamma+1\right]w(m)=kr(m)+(\gamma+1-k\lambda)w(m)$$

(b) $r(m+1)=3.5\,r(m)-250\,w(m)$

$w(m+1)=0.004\,r(m)-w(m)$

(c) 假设兔狼数只受彼此间的影响，即狼只吃兔，兔只被狼吃；假设兔的增长率为常数；用线性公式近似狼兔间捕食关系.

2.54 (a) $x(t)=\frac{2}{\tau^2}t\left[1(t)-1(t-\tau)\right]$

$$X(s)=\frac{2}{\tau^2s^2}-e^{-\tau s}\frac{2}{\tau^2s^2}-e^{-\tau s}\frac{2}{\tau s}=\frac{2(1-e^{-\tau s}-\tau se^{-\tau s})}{\tau^2s}$$

(b) $$\lim_{\tau\to0}X(s)=\lim_{\tau\to0}\frac{2(1-e^{-\tau s}-\tau se^{-\tau s})}{\tau^2s^2}$$

$$=\lim_{\tau\to0}\frac{2se^{-\tau s}-2se^{-\tau s}+2\tau s^2e^{-\tau s}}{2\tau s^2}$$

$$=\lim_{\tau\to0}e^{-\tau s}$$

$$=1$$

(c) 当 $\tau\to0$ 且冲量不变时，$x(t)$ 即成为 $\delta(t)$.