1. $H_a(s) = \frac{s+3}{(s+2)(s+4)}$, $T = 0.2s$

脉冲：$H_a(s) = \frac{\frac{1}{2}}{s+2} - \frac{\frac{1}{2}}{s+4}$

$$H(z) = \sum_{i=1}^{N} \frac{TA_i}{1-e^{s_i T}z^{-1}} = \frac{\frac{1}{2}T}{1-e^{-2T}z^{-1}} - \frac{\frac{1}{2}T}{1-e^{-4T}z^{-1}}$$

$$= \frac{\frac{1}{10}}{1-e^{-\frac{2}{5}}z^{-1}} - \frac{\frac{1}{10}}{1-e^{-\frac{4}{5}}z^{-1}}$$

双线性：$H(z) = H_a(s)\Big|_{s=\frac{2}{T}\frac{1-z^{-1}}{1+z^{-1}}}$

$$= \frac{\frac{2}{T}\frac{1-z^{-1}}{1+z^{-1}} + 3}{\left(\frac{2}{T}\frac{1-z^{-1}}{1+z^{-1}} + 2\right)\left(\frac{2}{T}\frac{1-z^{-1}}{1+z^{-1}} + 4\right)}$$

$$= \frac{(13-7z^{-1})(1+z^{-1})}{(12-8z^{-1})(14-6z^{-1})}$$

2、① $w_p=0.8\pi rad/s$ $\alpha_p=3dB$

$w_s=0.5\pi rad/s$ $\alpha_s=18dB$

(1) ① 模拟高通边界频率，$T=1s$

$\Omega_p=\frac{2}{T}\tan\frac{w_p}{2}=2\tan 0.4\pi=6.1553\ rad/s$

$\alpha_p=3dB$

$\Omega_s=\frac{2}{T}\tan\frac{w_s}{2}=2\tan 0.25\pi=2rad/s$ $\alpha_s=18dB$

(2) ① 模拟低通指标，$\Omega_p=\Omega_c$

$\eta_p=\frac{\Omega_p}{\Omega_c}=1$ $\eta_s=\frac{\Omega_s}{\Omega_c}=\frac{2}{6.1553}=0.3249$

低通指标为：

$\lambda_p=\frac{1}{\eta_p}=1$，$\alpha_p=3dB$

$\lambda_s=\frac{1}{\eta_s}=3.0777$ $\alpha_s=18dB$

② $N\geq\frac{\lg[(10^{2.1/10}-1)/(10^{3/10}-1)]}{2\lg(\Omega_s/\Omega_p)}=1.8425$ 取 $N=2$

$G(p)=\frac{1}{p^2+1.414p+1}$

③ $H_a(s)=G_p(p)|_{p=\frac{\Omega_c}{s}}=\frac{s^2}{s^2+8.7036s+37.8871}$

(3) ① $H(z)=H_a(s)|_{s=\frac{2}{T}\frac{1-z^{-1}}{1+z^{-1}}}=\frac{0.0675-0.1349z^{-1}+0.0675z^{-2}}{1+1.1430z^{-1}+0.4128z^{-2}}$