① SP5 2015010210KS

A.1.

a. No "s" in numerator $\Rightarrow$ LP

b. $\omega_0^2 = \frac{1}{(2CR)^2} \Rightarrow R = \frac{1}{2\omega_0 C} = \underline{\underline{7958\ \Omega}}$

$\frac{\omega_0}{Q} = \frac{5-\mu_1\mu_2}{4CR} = \frac{5-\mu_1\mu_2}{2}\cdot\omega_0 \Rightarrow Q = \frac{2}{5-\mu_1\mu_2}$

$\mu_1 = \frac{1}{\mu_2}\left(5 - \frac{2}{Q}\right) = \frac{4{,}5}{2} = \underline{\underline{2{,}25}}$

c. $H(j0) = \mu_1\mu_2 = 4{,}5 \sim \underline{\underline{13.06\ dB}}$

$H(j\omega_0) = \frac{\frac{\mu_1\mu_2}{(2RC)^2}}{-\omega_0^2 + \frac{5-\mu_1\mu_2}{4CR}\cdot\frac{1}{2CR} + \omega_0^2} = \frac{2\mu_1\mu_2}{5-\mu_1\mu_2} = \frac{9}{0{,}5} = 18 \sim \underline{\underline{25{,}11\,dB}}$

d. $S_{\mu_1}^{Q} = -S_{\mu_1}^{5-\mu_1\mu_2} = -\frac{\mu_1}{5-\mu_1\mu_2}\cdot(-\mu_2) = \frac{\mu_1\mu_2}{5-\mu_1\mu_2} = \frac{4{,}5}{0{,}5} = \underline{9}$

A.2.

a. Ripple in passband
No ripple in stopband
2 "hills", 2 "valleys"
} Chebyshev, 4^{th} order.

(LP $\Leftrightarrow$ HP does not change the order)

b. $\omega_{s,norm} = \frac{f_0}{f_s} = 4$

$\varepsilon = \sqrt{10^{1{,}25/10} - 1} = 0{,}5775$

$X = 10\cdot\log\left(1 + \varepsilon^2 C_4^2(4)\right) = 10\cdot\log\left(1 + (\varepsilon\cdot\cosh(4\cdot\operatorname{acosh}(4)))^2\right)$

$= \underline{\underline{60{,}90\,dB}}$

c. $H(j\omega_{norm}) = 1 \Leftrightarrow C_4(\omega_{norm}) = 0 \Leftrightarrow \cos(4\cdot\operatorname{acos}(\omega_{norm})) = 0$

$\Leftrightarrow 4\cdot\operatorname{acos}(\omega_{norm}) = \frac{\pi}{2} + k\cdot\pi$

$\Leftrightarrow \omega_{norm} = \cos\left(\frac{\pi}{8} + k\frac{\pi}{4}\right) = \begin{cases} 0{,}9239 & k=0 \\ 0{,}3827 & k=1 \end{cases}$ $\quad f_1 = \frac{f_0}{0{,}9239} = \underline{\underline{216.5\ Hz}}$

② SP5 20150102/OKS

A.3

a. $|H_{LPP}(j\omega)|^2 = \frac{1}{1+\omega^{2n}} \Rightarrow \omega = \sqrt[2n]{\frac{1}{|H_{LPP}(j\omega)|^2} - 1}$

$\omega_{s1} = \sqrt[4]{9} = \underline{\underline{1,732}}$

$\omega_{s2} = \sqrt[4]{99} = \underline{\underline{3.154}}$

b.

$\omega_s = \frac{\Omega_s^2 - \Omega_0^2}{B \cdot \Omega_s}$

$$\begin{cases} \sqrt[4]{9} \cdot B \cdot \Omega_{s1} = \Omega_{s1}^2 - \Omega_0^2 \\ \sqrt[4]{99} \cdot B \cdot \Omega_{s2} = \Omega_{s2}^2 - \Omega_0^2 \end{cases}$$

$B = \frac{\Omega_{s2}^2 - \Omega_{s1}^2}{\sqrt[4]{99} \cdot \Omega_{s2} - \sqrt[4]{9}\,\Omega_{s1}} = \underline{\underline{943 \text{ rad/s}}}$

$\Omega_0 = \sqrt{\Omega_{s1}^2 - \sqrt[4]{9} \cdot B \cdot \Omega_{s1}} = \underline{\underline{2025 \text{ rad/s}}}$