Chitrangada

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Q.3)

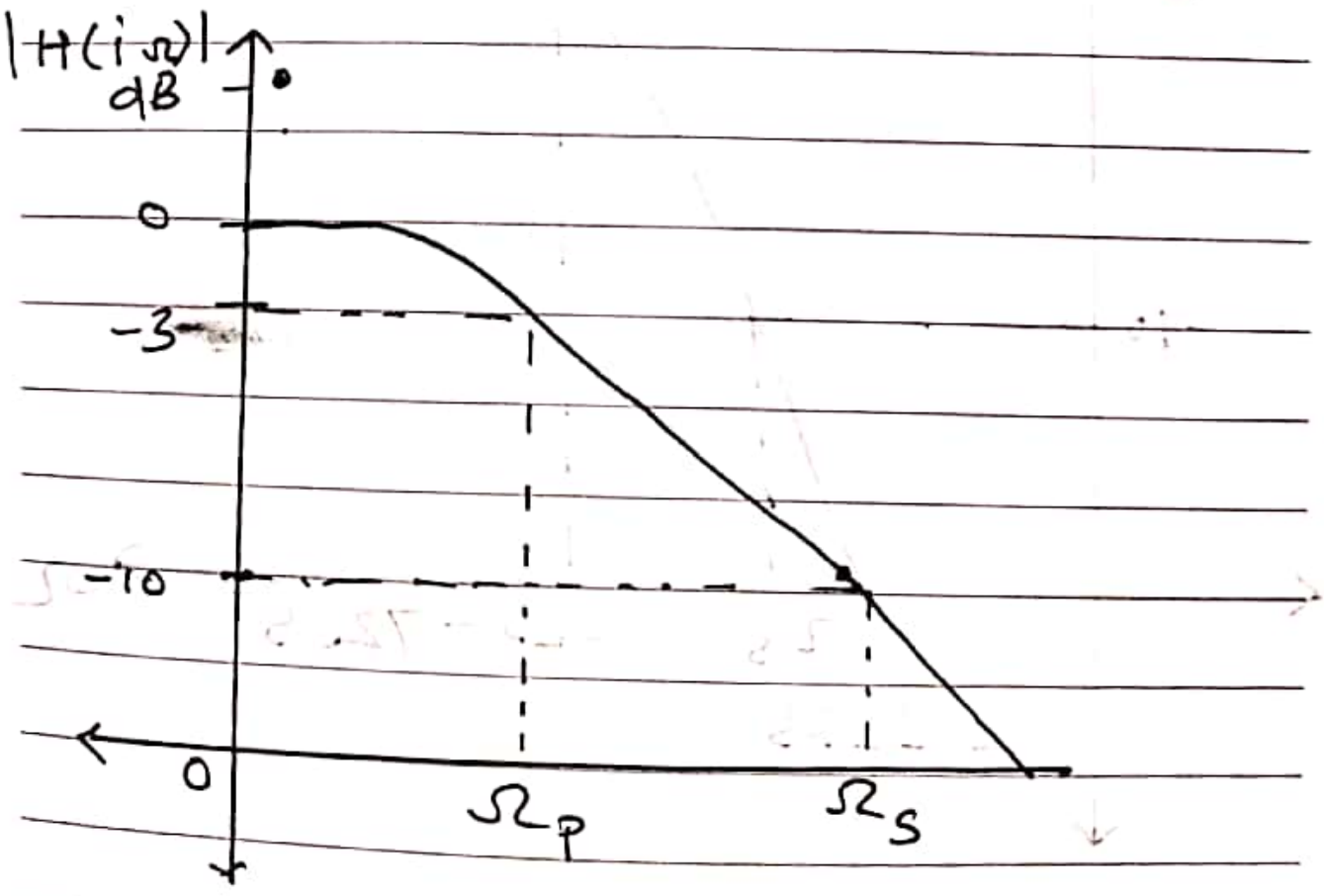
$\alpha_p = 3dB$

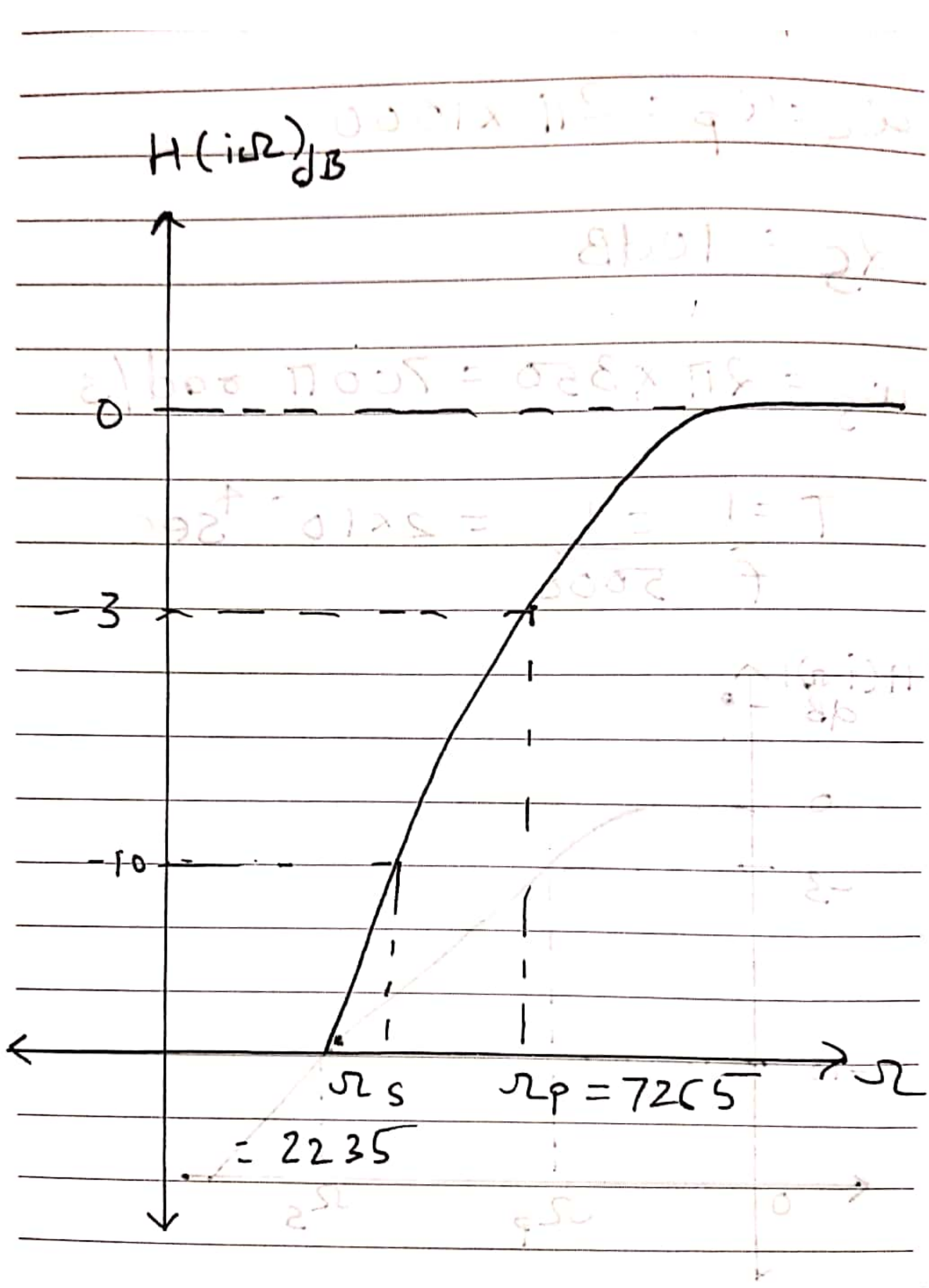
$\omega_c = \omega_p = 2\pi \times 1000$

$\alpha_s = 10dB$

$\omega_s = 2\pi \times 350 = 700\pi$ rad/s

$T = \frac{1}{f} = \frac{1}{5000} = 2 \times 10^{-4}$ sec





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The characterics are monotonic in both passband & stopband It is butterworth filter.

Preworping digital frequencies.

$$\Omega_p = \frac{2}{T}\tan\frac{\omega_p T}{2} = \frac{2}{2\times10^{-4}}\tan\left(\frac{2000\pi\times10^{-4}}{2}\right)$$

$$= 10^4 \tan(0.2\pi)$$

$$= 7265 \text{ rad/s}.$$

$$\Omega_s = \frac{2}{T}\tan\frac{\omega_s T}{2}$$

$$= \frac{2}{2\times10^{-4}}\tan\left(\frac{2007\pi\times2\times10^{-4}}{2}\right)$$

$$= 10^4 \tan(0.07\pi).$$

$$= 2235 \text{ rad/s}.$$

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First, design low pass filter & from given specifications & use suitable transformation to obtain transfer f^n of HPF.

$$N = \log \sqrt{\frac{10^{0.1\alpha_s} - 1}{10^{0.1\alpha_p} - 1}} \Big/ \log \frac{\Omega_s}{\Omega_p}$$

$$= \frac{\log 3}{\log 3.25} = \frac{0.4771}{0.5118} = 0.932$$

Therefore $N = 1$

1st order Butterworth filter $\Omega_c = 1$ rad/s

$$H(s) = \frac{1}{1+s}$$

The HPF $\Omega_c = \Omega_p = 7265$ rad/s can be obtained by using the transformation

$$s \rightarrow \frac{\Omega_c}{s} \quad \text{i.e.} \quad s \rightarrow \frac{7265}{s}$$

Using BLT

$$H(z) = H(s)\Big|_{s=\frac{2}{T}\left(\frac{1-z^{-1}}{1+z^{-1}}\right)}$$

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$$= \frac{S}{S + 7265} \Big|_{s=\frac{2}{2\times10^{-4}}} \left(\frac{1 - z^{-1}}{1 + z^{-1}}\right)$$

$$= 1000 \left(\frac{1 - z^{-1}}{1 + z^{-1}}\right)$$

$$\frac{1000 \left(\frac{1 - z^{-1}}{1 + z^{-1}}\right)}{1000 \left(\frac{1 - z^{-1}}{1 + z^{-1}}\right) + 7265}$$

$$= \frac{0.5792 (1 - z^{-1})}{1 - 0.1584 z^{-1}}$$