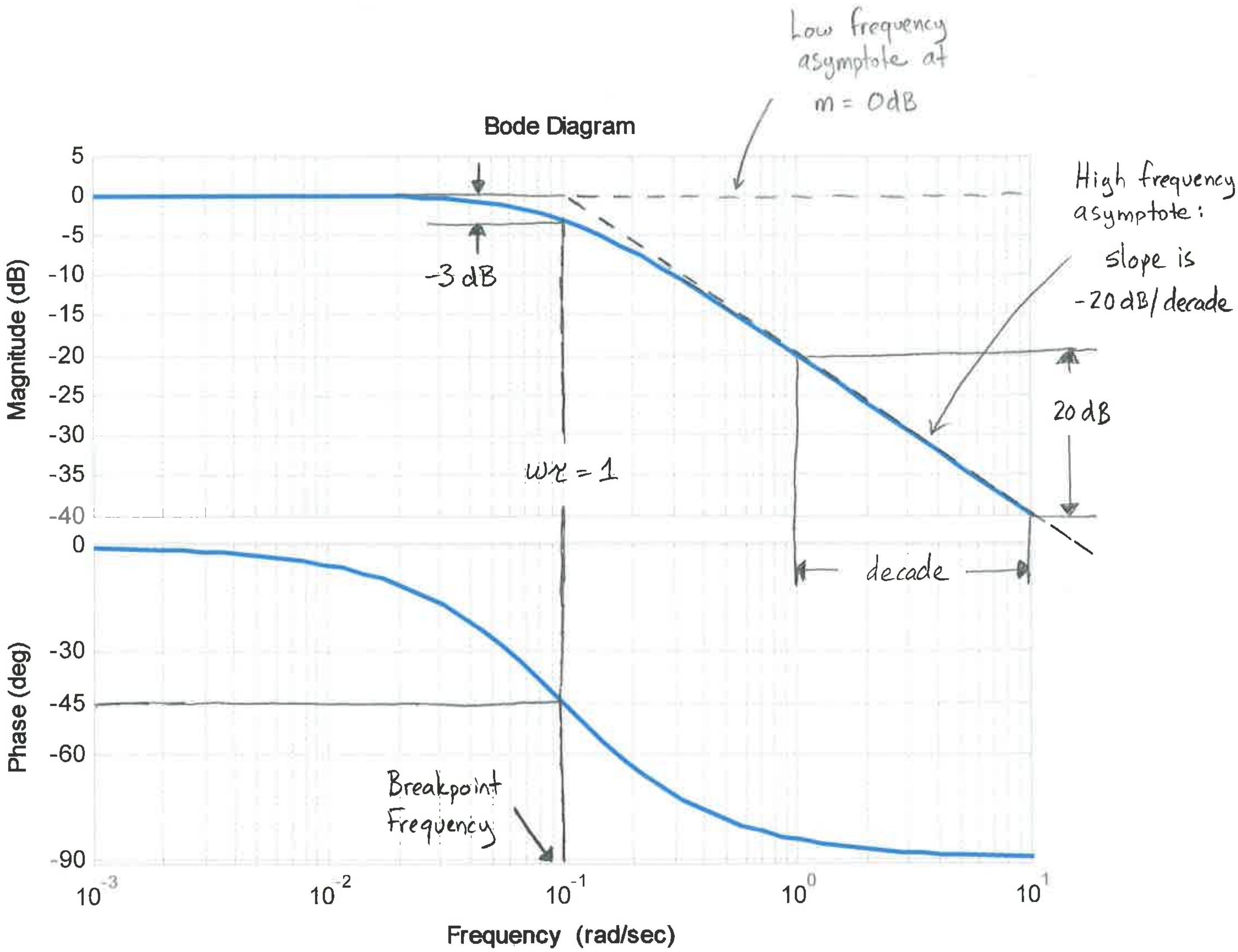
Hand Sketching Bode Plots

Bode Plots for $T(s) = \frac{1}{\tau s + 1}$, $\tau = 10$



To sketch m vs. ω, we can approximate $m(\omega)$ in three frequency ranges

- for $\tau\omega \ll 1$, $(1+\tau^2\omega^2) \approx 1 \Rightarrow m = -10\log(1) = 0 \Rightarrow m = 0$ (low frequency asymptote)
- for $\tau\omega \gg 1$, $(1+\tau^2\omega^2) \approx \tau^2\omega^2 \Rightarrow m = -10\log(\tau^2\omega^2) = -20\log(\tau\omega) = -20\log\tau - 20\log\omega$
  - ★ This gives a straight line vs $\log\omega$. This is the high frequency asymptote, whose slope is -20 dB/decade
- for $\tau\omega = 1$, $(1+\tau^2\omega^2) = 2 \Rightarrow m = -10\log 2 = -3.01$
  - ★ So at $\omega = \frac{1}{\tau}$, $m(\omega)$ is 3 dB below the low frequency asymptote.
  - ★ $\omega = \frac{1}{\tau}$ is called the "breakpoint frequency" or "corner frequency".

To sketch ϕ vs ω: (recall $\phi = -\tan^{-1}(\omega\tau)$)

- for $\tau\omega \ll 1$, $\phi \approx -\tan^{-1}(0) = 0°$
- for $\tau\omega \gg 1$, $\phi \approx -\tan^{-1}(\infty) = -90°$
- for $\tau\omega = 1$, $\phi \approx -\tan^{-1}(1) = 45°$