

## RULES FOR ASYMPTOTIC BODE PLOT

### Constant K term:

**Magnitude plot:** Straight horizontal line at  $20\log(K)$  dB

**Phase plot:** no phase that is  $0^\circ$ .

The constant K term shifts the entire Magnitude Bode plot up or down by  $20\log(K)$  dB.

### Zero at the origin $(j\omega)^n$ :

**Magnitude plot:** Straight line passing through  $\omega = 1$  with a positive slope of  $n20\text{dB/dec}$  (trending upward). (**dec means decade or 10 divisions on the graph paper**).

**Phase plot:** Straight horizontal line at  $+n90^\circ$ .

### Zero not at the origin $(1 + j\omega/z)$ :

**Magnitude plot:** Straight horizontal line up to  $\omega = z$  at 0dB and at  $\omega = z$ , trends upward with a positive slope of  $20\text{dB/dec}$ .

**Phase plot:** Straight horizontal line at  $0^\circ$  up to  $0.1z$  and then slopes upward at  $45^\circ/\text{dec}$  up to  $10z$ , where it then stays at  $+90^\circ$  onwards.

### Pole at the origin $(j\omega)^{-n}$ :

**Magnitude plot:** Straight line passing through  $\omega = 1$  with a negative slope of  $20\text{dB/dec}$  (trending downward).

**Phase plot:** Straight horizontal line at  $-n90^\circ$ .

### Pole not at the origin $(1 + j\omega/p)^{-1}$ :

**Magnitude plot:** Straight horizontal line up to  $\omega = p$  at 0dB and at  $\omega = p$ , trends downward with a negative slope of  $20\text{dB/dec}$ .

**Phase plot:** Straight horizontal line at  $0^\circ$  up to  $0.1p$  and then slopes downward at  $45^\circ/\text{dec}$  up to  $10p$ , where it then stays at  $-90^\circ$  onwards.

**Quadratic zero:**  $\left(1 + a \frac{j\omega}{\omega_n} + b \frac{(j\omega)^2}{\omega_n^2}\right)$

**Magnitude plot:** Straight horizontal line up to  $\omega = \omega_n$  at 0dB and at  $\omega = \omega_n$ , trends upward with a positive slope of  $40\text{dB/dec}$ .

**Phase plot:** Straight horizontal line at  $0^\circ$  up to  $0.1\omega_n$  and then slopes upward at  $90^\circ/\text{dec}$  up to  $10\omega_n$ , where it then stays at  $+180^\circ$  onwards.

**Quadratic pole:**  $\left(1 + a \frac{j\omega}{\omega_n} + b \frac{(j\omega)^2}{\omega_n^2}\right)^{-1}$

**Magnitude plot:** Straight horizontal line up to  $\omega = \omega_n$  at 0dB and at  $\omega = \omega_n$ , trends downward with a negative slope of  $40\text{dB/dec}$ .

**Phase plot:** Straight horizontal line at  $0^\circ$  up to  $0.1\omega_n$  and then slopes downward at  $90^\circ/\text{dec}$  up to  $10\omega_n$ , where it then stays at  $-180^\circ$  onwards.