The <u>magnitude</u> of the complex velocity amplitude $\tilde{v}_o(\omega)$ of the microphone diaphragm is:

$$\left|\tilde{v}_{o}\left(\omega\right)\right| \equiv \sqrt{v_{or}^{2}\left(\omega\right) + v_{oi}^{2}\left(\omega\right)} = \omega \left(\frac{p_{o}A_{dia}}{m_{dia}}\right) \frac{1}{\sqrt{\left(\omega_{o}^{2} - \omega^{2}\right)^{2} + \omega^{2}\gamma_{dia}^{2}}}$$

If we again define $x(\omega) \equiv \omega/\omega_o$ and $y \equiv \gamma_{dia}/\omega_o$ then we can rewrite the {normalized} magnitude of the complex velocity amplitude $\tilde{v}_o(\omega)$ and *v*-phase as:

$$v \cdot \operatorname{Res}\left(x(\omega)\right) = \frac{\omega_o \left|\tilde{v}_o(\omega)\right|}{\left(\frac{p_o A_{dia}}{m_{dia}}\right)} = \frac{\left(\frac{\omega}{\omega_o}\right)}{\sqrt{\left[1 - \left(\frac{\omega}{\omega_o}\right)^2\right]^2 + \left(\frac{\omega}{\omega_o}\right)^2 \left(\frac{\gamma_{dia}}{\omega_o}\right)^2}} = \frac{x}{\sqrt{\left(1 - x^2\right)^2 + x^2 y^2}}$$
$$\varphi_v(\omega) = \tan^{-1}\left(\frac{\left(\frac{\omega_o^2 - \omega^2}{\omega_o^2}\right)}{\omega_{\gamma_{dia}}}\right) = \tan^{-1}\left(\frac{1 - \left(\frac{\omega}{\omega_o}\right)^2}{\left(\frac{\omega}{\omega_o}\right) \left(\frac{\gamma_{dia}}{\omega_o}\right)}\right) = \tan^{-1}\left(\frac{1 - x^2}{x \cdot y}\right)$$

We again have the usual three conditions of <u>underdamped</u>, <u>critically</u> <u>damped</u> and <u>overdamped</u> motion for $y \equiv \gamma_{dia}/\omega_o \ll 1$, $y \equiv \gamma_{dia}/\omega_o = 1$ and $y \equiv \gamma_{dia}/\omega_o \gg 1$, respectively. The following two color-coded figures show normalized v-Res(x) vs. x and v-Phase(x) vs. x for y = 0.05 (pink), 1.0 (cyan) and 10.0 (violet):



-24-©Professor Steven Errede, Department of Physics, University of Illinois at Urbana-Champaign, Illinois 2002 - 2017. All rights reserved.