From the above two figures, we see that if we ***overdamp*** the diaphragm of the microphone ($y \equiv \gamma_{dia}/\omega_o = 10$, violet curves), we achieve a region of flat frequency response, albeit with ***non-constant*** phase shift over the {fractional} frequency range $0.01 \le x(\omega) \equiv \omega/\omega_o \le 100$. These response curves are relevant for the design of microphones whose output signal response $\tilde{V}_{mic}(t)$ to an over-pressure $\tilde{p}(\vec{r},t)$ that is linearly proportional to the ***displacement*** of the diaphragm, $\tilde{x}_{dia}(t)$ - *e.g* ***electret condenser-type*** microphones.

The output responses of ***dynamic*** and ***ribbon-type*** microphones to an over-pressure $\tilde{p}(t)$ are linearly proportional to the ***velocity*** of the diaphragm of the microphone, $\tilde{v}_{dia}(t) = \partial\tilde{x}_{dia}(t)/\partial t$, since *e.g.* a time-varying *EMF* (*i.e.* voltage) $\tilde{\varepsilon}_{mic}(t) = \left|\vec{\tilde{v}}_{dia}(t)\right| \cdot \left|\vec{B}_o\right| \cdot \ell_{ribbon}$ {where $\ell_{ribbon}(m)$ is the length of the metal ribbon} is produced across the top/bottom of the corrugated metal ribbon diaphragm due to the instantaneous differential over-pressure $\Delta\tilde{p}_{ribbon}(t)$ acting on it.

We have already seen that a harmonically-varying overpressure amplitude at the diaphragm of the microphone $\tilde{p}(t) = p_o e^{i\omega t}$ results in a harmonically-varying displacement of the microphone $\tilde{x}_{dia}(t) = \tilde{x}_o(\omega) e^{i\omega t}$. Thus $\tilde{v}_{dia}(t) = \partial\tilde{x}_{dia}(t)/\partial t = i\omega\tilde{x}_o(\omega)e^{i\omega t} = i\omega\tilde{x}_{dia}(t)$, *i.e.* the velocity of the diaphragm $\tilde{v}_{dia}(t)$ is +90° ahead in phase relative to the displacement of the diaphragm, $\tilde{x}_{dia}(t)$ and is also linearly proportional to the (angular) frequency $\omega = 2\pi f$.
We also see that $\tilde{v}_{dia}(t) = \partial\tilde{x}_{dia}(t)/\partial t = i\omega\tilde{x}_o(\omega)e^{i\omega t} = i\omega\tilde{x}_{dia}(t) = \tilde{v}_o(\omega)e^{i\omega t}$ and hence that $\tilde{v}_o(\omega) = i\omega\tilde{x}_o(\omega)$. Thus the complex velocity amplitude of the diaphragm of a microphone is:

$$\tilde{v}_o(\omega) = i\omega\tilde{x}_o(\omega) = i\omega\left(\frac{p_o A_{dia}}{m_{dia}}\right)\frac{\left[\left(\omega_o^2 - \omega^2\right) - i\omega\gamma_{dia}\right]}{\left(\omega_o^2 - \omega^2\right)^2 + \omega^2\gamma_{dia}^2} = \omega\left(\frac{p_o A_{dia}}{m_{dia}}\right)\frac{\left[\omega\gamma_{dia} + i\left(\omega_o^2 - \omega^2\right)\right]}{\left(\omega_o^2 - \omega^2\right)^2 + \omega^2\gamma_{dia}^2}$$

The ***real/in-phase component*** of the velocity amplitude $\tilde{v}_o(\omega)$ of the microphone diaphragm is:

$$v_{o\,r}(\omega) \equiv \text{Im}\left\{\tilde{v}_o(\omega)\right\} = \omega\left(\frac{p_o A_{dia}}{m_{dia}}\right)\frac{\omega\gamma_{dia}}{\left(\omega_o^2 - \omega^2\right)^2 + \omega^2\gamma_{dia}^2}$$

The ***imaginary/quadrature component*** of the velocity amplitude $\tilde{v}_o(\omega)$ of the microphone diaphragm is:

$$v_{o\,i}(\omega) \equiv \text{Re}\left\{\tilde{v}_o(\omega)\right\} = \omega\left(\frac{p_o A_{dia}}{m_{dia}}\right)\frac{\left(\omega_o^2 - \omega^2\right)}{\left(\omega_o^2 - \omega^2\right)^2 + \omega^2\gamma_{dia}^2}$$

The ***phase*** of the velocity amplitude $\tilde{v}_o(\omega)$ of the microphone diaphragm is:

$$\varphi_v(\omega) \equiv \tan^{-1}\left(\frac{\text{Im}\left\{\tilde{v}_o(\omega)\right\}}{\text{Re}\left\{\tilde{v}_o(\omega)\right\}}\right) = \tan^{-1}\left(\frac{\left(\omega_o^2 - \omega^2\right)}{\omega\gamma_{dia}}\right)$$