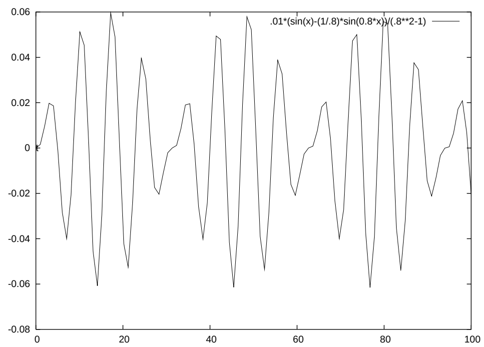
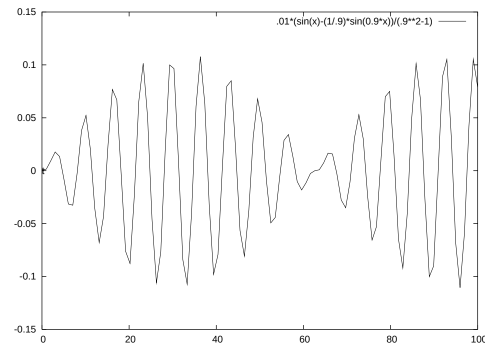
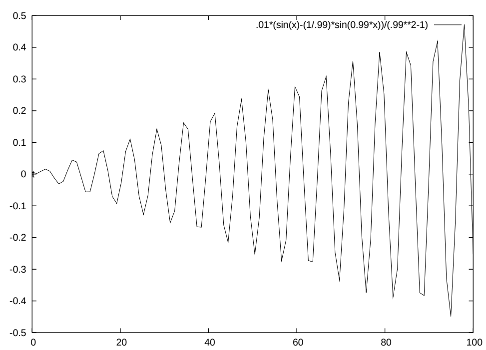
2.8.4: The validity is checked by substituting the solution into Eq. (2.410) and the boundary conditions.

1. The amplitude of $y(t)$ depends very much on $\omega - \omega_\beta$.







2. Let $\epsilon = \omega_\beta - \omega$. We find that the displacement becomes

$$y(t) \approx \frac{\hat{F}}{2\omega}\left[\frac{1-\cos(\epsilon t)}{\epsilon}\sin\omega t - \frac{\sin(\epsilon t)}{\epsilon}\cos\omega t\right].$$
$$\dot{y}(t) \approx \frac{\hat{F}}{2}\left[\frac{1-\cos(\epsilon t)}{\epsilon}\cos\omega t + \frac{\sin(\epsilon t)}{\epsilon}\sin\omega t\right].$$

The average power of the external force is

$$\langle P(T)\rangle = \frac{1}{T}\int_0^T \dot{y}\,\hat{F}\sin\omega t dt$$

Thus the first term is averaged to be zero, while the second term produces the dissipative force.

3. For a given beam distribution with frequency spread (in ϵ), the first term is an odd function of ϵ, and the average of a distribution with even function in ϵ is zero. On the other hand, the second term will increase linearly with time, i.e.

$$\langle y(t)\rangle \approx \frac{\hat{F}}{2\omega}\left(\int \frac{sinx}{x}dx\right) t\cos\omega t.$$

3.7.3:

The parameters of the SLC damping ring are $E = 1.15$ GeV, $\nu_x = 8.2$, $\nu_z = 3.2$, $\alpha_{\rm c} = 0.0147$, $\gamma\epsilon_{x,z} = 15\ \pi$ mm-mrad, $\sigma_{\Delta p/p} = 7.1 \times 10^{-4}$, $V_{\rm rf} = 800$ kV, $C = 35.270$ m, $h = 84$, $f_{\rm rf} = 714$ MHz, $\rho = 2.0372$ m, and the energy loss per revolution is $U_0 = 93.1$ keV.

The synchrotron tune is $\nu_s = 1.17 \times 10^{-2}$. The bunch length is about 17 ps. If the threshold of bunch lengthening is $N_{\rm B} = 1.5 \times 10^{10}$, The impedance estimated from Keil-Schnell formula is $Z/n \sim 1\ \Omega$.