Homework Assignment 2

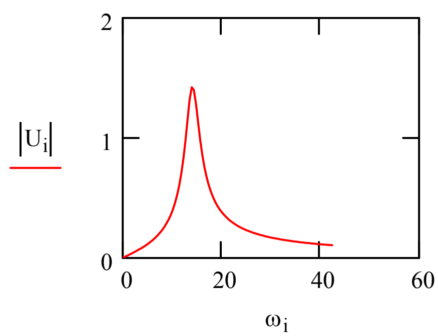
Problem 1.7.6C

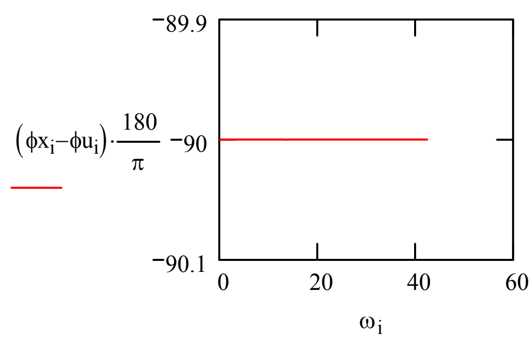
$m := 0.5 \quad s := 100 \quad R_m := 1.4 \quad F := 2 \quad \omega_n := \sqrt{\frac{s}{m}} \quad \omega_n = 14.142 \quad j := \sqrt{-1}$

$N := 100 \quad i := 0, 1 .. N \quad \omega_{start} := 0.01 \quad \omega_{end} := 3 \cdot \omega_n \quad \omega_i := \frac{i}{N} \cdot (\omega_{end} - \omega_{start}) + \omega_{start}$

$X_i := \frac{F}{(j \cdot \omega_i)^2 \cdot m + R_m \cdot (j \cdot \omega_i) + s} \qquad U_i := \frac{F}{(j \cdot \omega_i) \cdot m + R_m + \frac{s}{(j \cdot \omega_i)}}$

$\phi x_i := \arg(X_i) \qquad \phi u_i := \arg(U_i)$





Phase angle between displacement and amplitude is always 90 degrees, don't really understand the last part of the question.

Problem 1.10.2

$m := 0.5 \quad s := 100 \quad R_m := 1.4 \quad \omega := 5 \quad F := 2 + 0 \cdot j$

$X := \frac{F}{(j \cdot \omega)^2 \cdot m + R_m \cdot (j \cdot \omega) + s} \quad U := \frac{F}{(j \cdot \omega) \cdot m + R_m + \frac{s}{(j \cdot \omega)}} \quad |X| = 0.023 \quad |U| = 0.114$

$\Pi := \frac{1}{2} \cdot \mathrm{Re}(F \cdot \overline{U}) \qquad \Pi = 9.085 \times 10^{-3}$

$\phi x := \arg(X) \quad \phi F := \arg(F) \quad (\phi x - \phi F) \cdot \frac{180}{\pi} = -4.574$

$\omega_n := \sqrt{\frac{s}{m}} \quad \omega_n = 14.142 \quad \omega := \omega_n \quad X := \frac{F}{(j \cdot \omega)^2 \cdot m + R_m \cdot (j \cdot \omega) + s} \quad |X| = 0.101$

$U := \frac{F}{(j\cdot\omega)\cdot m + R_m + \frac{s}{(j\cdot\omega)}}$ $|U| = 1.429$ $\Pi := \frac{1}{2}\cdot Re(F\cdot\overline{U})$ $\Pi = 1.429$

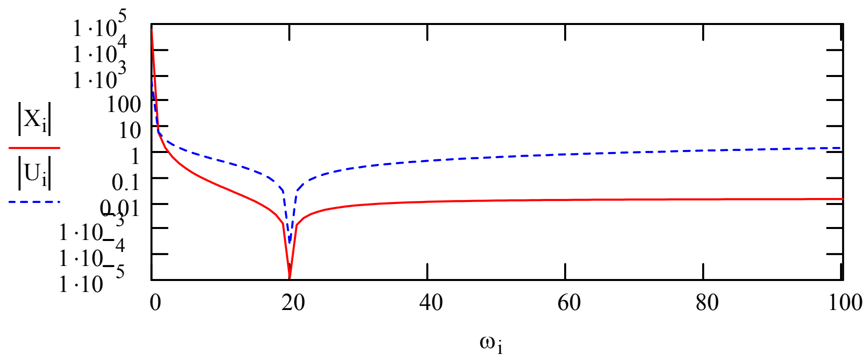
$Q := \frac{m\cdot\omega_n}{R_m}$ $Q = 5.051$ $\Delta\omega := \frac{\omega_n}{Q}$ $\Delta\omega = 2.8$

Problem 1.12.1 (see additional pdf file for rest of problem)

$m := 0.5$ $s := 200$ $F := 3 + 0\cdot j$

$N := 100$ $i := 0, 1 .. N$ $\omega_{start} := 0.01$ $\omega_{end} := 100$ $\omega_i := \frac{i}{N}\cdot(\omega_{end} - \omega_{start}) + \omega_{start}$

$X_i := \frac{1}{(j\cdot\omega_i)^2\cdot m}\cdot\left[1 + \frac{m}{s}\cdot(j\cdot\omega_i)^2\right]\cdot F$ $U_i := \frac{1}{(j\cdot\omega_i)\cdot m}\cdot\left[1 + \frac{m}{s}\cdot(j\cdot\omega_i)^2\right]\cdot F$



Loudspeaker Driver Problem

Compute the moving mass, mechanical damping coefficient, and spring stiffness of the loudspeaker driver

Properties of Air (should be corrected for elevation, temp, and barometric temperature)

$\rho := 1.21$ $c := 343$

Specifications for Pioneer 4-1/2" Full Range (#290-101)

$V_{as} := 0.31$ $V_{as} := V_{as}\cdot 12^3\cdot 0.0254^3$ $V_{as} = 8.778\times 10^{-3}$ $R_o := 7.4$ $f_s := 70$

$Q_{ms} := 1.4$ $Q_{es} := 0.47$ $Q_t := \frac{1}{\frac{1}{Q_{es}} + \frac{1}{Q_{ms}}}$ $Q_t = 0.352$

$S_d := 0.0668$ $\qquad S_d := S_d \cdot 12^2 \cdot 0.0254^2$ $\qquad S_d = 6.206 \times 10^{-3}$

Compute Model Parameters from Manufacture's Specs

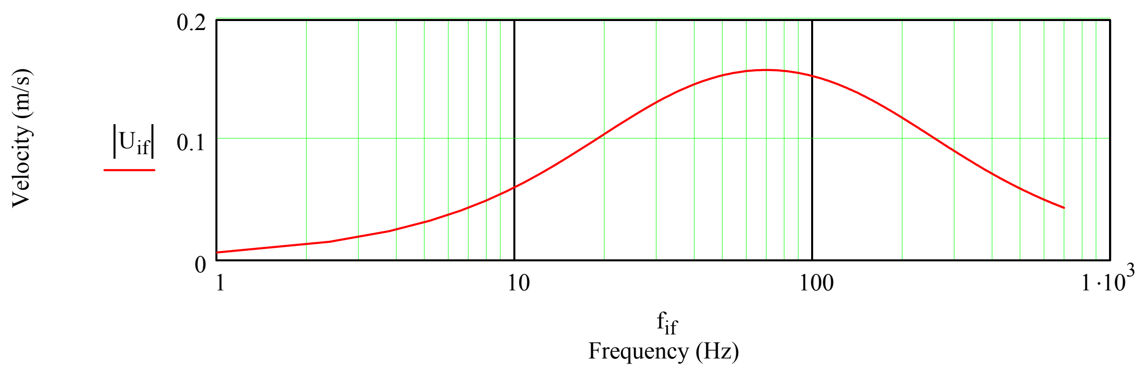
$s := \frac{\rho \cdot c^2 \cdot S_d^2}{V_{as}}$ $\qquad s = 624.568$ $\qquad m := \frac{s}{4 \cdot \pi^2 \cdot f_s^2}$ $\qquad m = 3.229 \times 10^{-3}$

$Bl := \sqrt{\frac{R_o \cdot s}{Q_{es} \cdot (2 \cdot \pi \cdot f_s)}}$ $\qquad Bl = 4.728$ $\qquad R_m := \frac{s}{Q_{ms} \cdot (2 \cdot \pi \cdot f_s)}$ $\qquad R_m = 1.014$

Given an input harmonic voltage of amplitude 1 V, plot the velocity amplitude in mm/s versus frequency over a frequency ranging from zero to twice the free air natural frequency. Assume that the driver operates in a vacuum

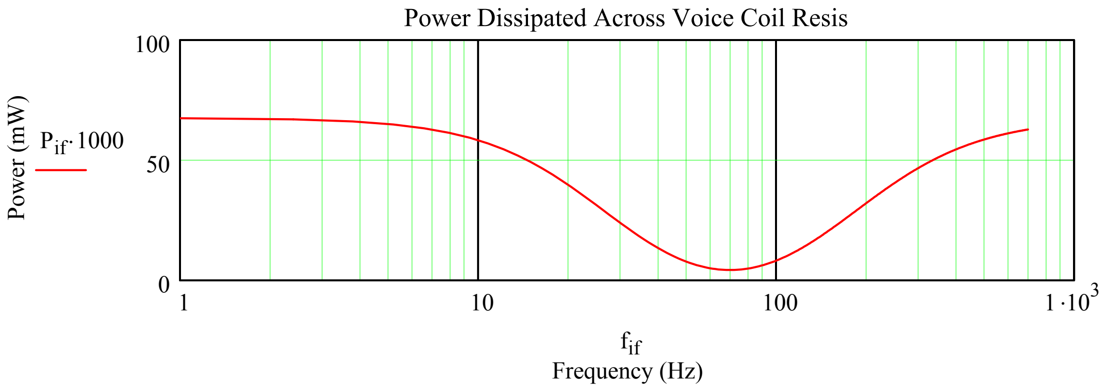
$Nf := 500 \quad if := 0, 1 .. Nf \quad f_{start} := 1 \qquad f_{end} := 10 \cdot f_s \qquad f_{if} := \frac{if}{Nf} \cdot (f_{end} - f_{start}) + f_{start} \qquad j := \sqrt{-1}$

$$V := 1 + 0 \cdot j \qquad U_{if} := \frac{Bl \cdot ((2 \cdot \pi \cdot f_s))}{R_o \cdot s} \cdot \frac{\left(j \cdot \frac{2 \cdot \pi \cdot f_{if}}{2 \cdot \pi f_s}\right)}{\left(j \cdot \frac{2 \cdot \pi \cdot f_{if}}{2 \cdot \pi f_s}\right)^2 + \frac{1}{Q_t} \cdot \left(j \cdot \frac{2 \cdot \pi \cdot f_{if}}{2 \cdot \pi f_s}\right) + 1} \cdot V$$



Over the same frequency range, plot the power in milli-Watts dissipated in the coil resistance. (neglect inductance).

$I_{if} := \frac{V - Bl \cdot U_{if}}{R_o}$ $\qquad VR_{if} := R_o \cdot I_{if}$ $\qquad P_{if} := \frac{1}{2} \cdot Re\left(VR_{if} \cdot \overline{I_{if}}\right)$


Power Dissipated Across Voice Coil Resis
100
50
0
Power (mW)
$P_{if} \cdot 1000$
1
10
100
$1 \cdot 10^3$
f_{if}
Frequency (Hz)