ECEN325 Ref Sheet © Josh Wright February 6, 2017

Metric Prefixes

peta	P	10^{15}	1 000 000 000 000 000
tera	T	10^{12}	1 000 000 000 000
giga	G	10^{9}	1 000 000 000
mega	M	10^{6}	1 000 000
kilo	k	10^{3}	1 000
hecto	h	10^{2}	100
deca	da	10^{1}	10
one		10^{0}	1
deci	d	10^{-1}	0.1
centi	c	10^{-2}	0.01
milli	m	10^{-3}	0.001
micro	μ	10^{-6}	0.000 001
nano	n	10^{-9}	0.000 000 001
pico	p	10^{-12}	0.000 000 000 001
femto	f	10^{-15}	0.000 000 000 000 001

RC Filter

- Transmission Function: $T(s) = \frac{V_o(s)}{V_i(s)}$
- Corner frequency: frequency s at which $T(s) = \frac{1}{\sqrt{2}}$
- for simple circuit: ground→source→ $R \rightarrow C$ →ground
  - $T(s) = \frac{1}{1+RCs}$
    $|T(j\omega)| = \frac{1}{\sqrt{1+R^2C^2s^2}}$
    $|\angle T(j\omega)| = \frac{1}{\sqrt{1+R^2C^2s^2}}$

Bode Plots

- magnitude is plotted in dB:
  $|T(j\omega)|_{dB} = 20\log_{10}|T(j\omega)|$
- starts on y-axis at DC offset with slope 0
- just add together the bode plots of each individual pole, zero, and the DC offset
- poles always slope down, zeros slope up (applies for both magnitude and phase)
- dec=decade, e.g. from 10^0 to 10^1
- magnitude:
  - Pole/Zero at origin:
    constant slope $\pm 20db/dec$ for all ω; $0dB$ at $\omega = 10^0 = 1$
  - Pole/Zero at ω_0:
    0 for $\omega < \omega_0$
    slope $\pm 20\frac{db}{dec}$ after
  - Constant C: constant line at $20\log_{10}(|C|)$
- phase:
  - Pole at origin: constant $-\frac{\pi}{2}$ or $-90°$
  - Zero at origin: constant $+\frac{\pi}{2}$ or $+90°$
  - Pole/Zero at ω_0:
    0 for $\omega < \frac{\omega_0}{10}$
    slope linearly $(\pm 45°/dec)$ until $10\omega_0$
    0 slope for $\omega > 10\omega_0$
  - Constant C: no effect (0 for all ω)

Solving systems with Op Amps

- step 0: if the op amp is ideal, write out ideal properties:
  - $V_+ = V_-$
  - $I_- = 0, I_+ = 0$
- avoid doing KCL/KVL on the output node of the op amp
- ignore resistors from a point at $0V$ to ground