ENGR-2300 **Crib Sheet** **Quiz 2**

DO NOT WRITE ON THIS SHEET **RETURN SHEET AFTER QUIZ**

Thevenin Voltage Sources

Find Vth	Set load between A and B to open and find $V_A - V_B$	$V_L = \frac{R_L}{R_{th}+R_L}V_{th}$
Find Rth	Set voltage sources to shorts and find combined resistance between A and B.	

Harmonic Oscillation

UnDamped	Damped	Cantilever Beam
$\frac{d^2V}{dt^2}+\omega_0^2V=0$	$\frac{d^2V}{dt^2}+2\alpha\frac{dV}{dt}+\omega_0^2V=0$	$\frac{Ewt^3}{4l^3}=(m+m_n)(2\pi f_n)^2$
$v(t)=A\cos(\omega_0 t+\phi)$	$v(t)=Ae^{-\alpha t}\cos(\omega_0 t+\phi)$	$m=0.23m_{beam}$
$\omega_0=\frac{1}{\sqrt{LC}}$	$v_1=v_0e^{-\alpha(t_1-t_0)}$ $\alpha=\frac{R}{2L}$	

Op-Amp Circuits

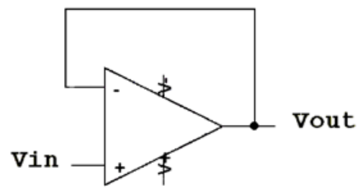
<u>Op Amp Analysis Rules</u>

1. $V_+=V_-$
2. $I_+=I_-=0$

<u>Op-Amp Analysis</u>

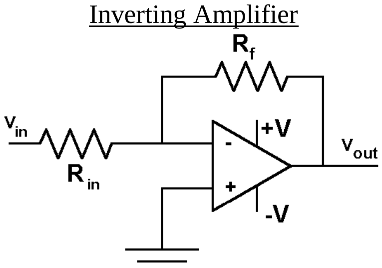
1. Remove Op-Amp
2. Draw a circuit at each input to the op-amp
3. Solve for Vout in terms of the input voltage(s).

<u>Voltage Follower</u>



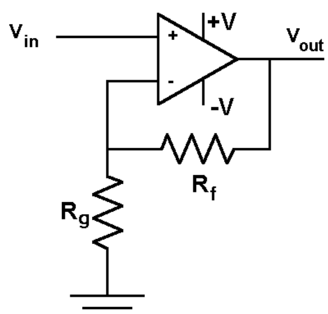
$$A_V=\frac{V_{out}}{V_{in}}=1$$

<u>Inverting Amplifier</u>



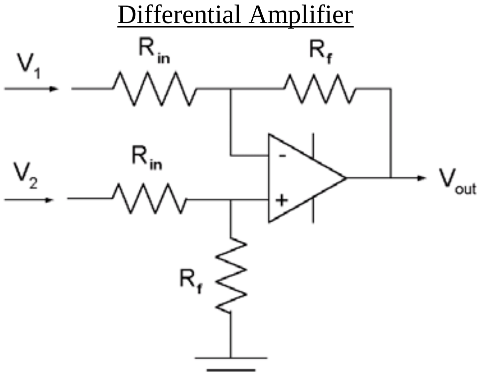
$$A_V=\frac{V_{out}}{V_{in}}=-\frac{R_f}{R_{in}}$$

<u>Non-Inverting Amplifier</u>



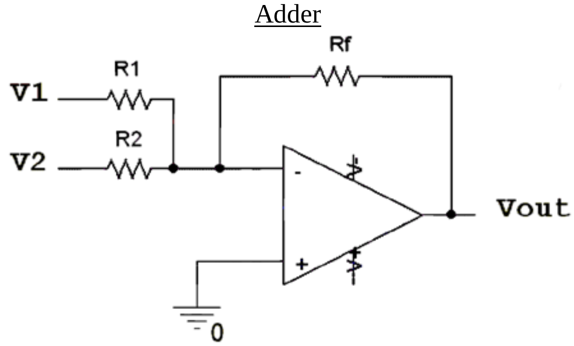
$$A_V=\frac{V_{out}}{V_{in}}=1+\frac{R_f}{R_g}$$

<u>Differential Amplifier</u>



$$V_{out}=\frac{R_f}{R_{in}}(V_2-V_1)$$

<u>Adder</u>



$$V_{out}=-\frac{R_f}{R_1}V_1-\frac{R_f}{R_2}V_2$$

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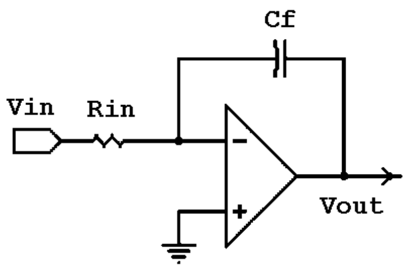
Ideal Active Integrator

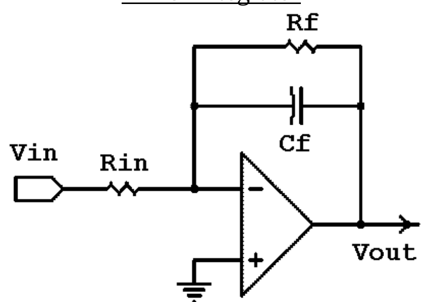


$$H(j\omega)=\frac{V_{out}}{V_{in}}=-\frac{1}{j\omega R_{in}C_f}$$

$$v_{out}(t)=-\frac{1}{R_{in}C_f}\int v_{in}(t)dt$$

$$\int \sin(\omega t)dt=\frac{-1}{\omega}\cos(\omega t)+K$$

Miller Integrator

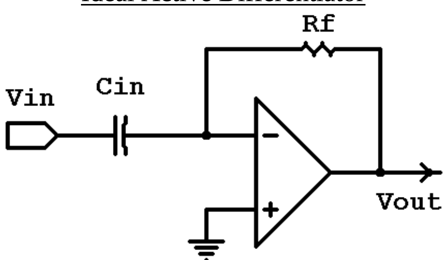


$$H(j\omega)=\frac{V_{out}}{V_{in}}=-\frac{R_f}{R_{in}(1+j\omega R_f C_f)}$$

$$\omega >> \frac{1}{R_f C_f} \Rightarrow H(j\omega)\approx -\frac{1}{j\omega R_{in}C_f}$$

$$\omega >> \frac{1}{R_f C_f} \Rightarrow v_{out}(t)\approx -\frac{1}{R_{in}C_f}\int v_{in}(t)dt$$

Ideal Active Differentiator

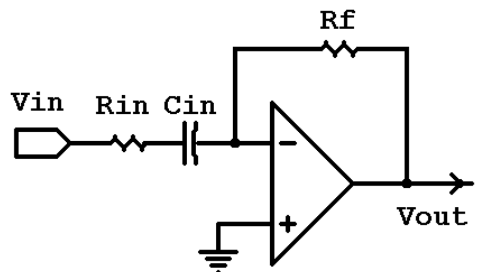


$$H(j\omega)=\frac{V_{out}}{V_{in}}=-j\omega R_f C_{in}$$

$$v_{out}(t)=-R_f C_{in}\frac{dv_{in}(t)}{dt}$$

$$\frac{d\sin(\omega t)}{dt}=\omega\cos(\omega t)$$

Practical Active Differentiator

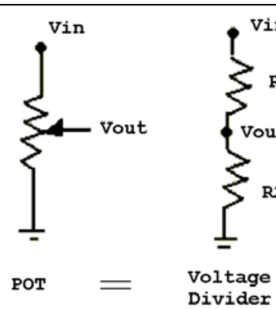


$$H(j\omega)=\frac{V_{out}}{V_{in}}=-\frac{j\omega R_f C_{in}}{1+j\omega R_{in}C_{in}}$$

$$\omega << \frac{1}{R_{in}C_{in}} \Rightarrow H(j\omega)\approx -j\omega R_f C_{in}$$

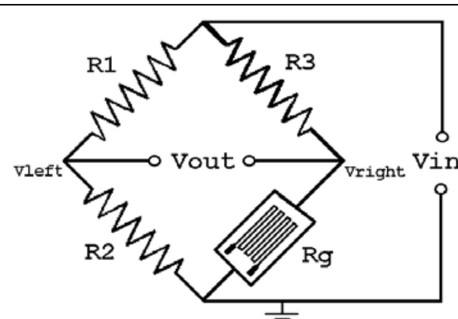
$$\omega << \frac{1}{R_{in}C_{in}} \Rightarrow v_{out}(t)=-R_f C_{in}\frac{dv_{in}(t)}{dt}$$

Potentiometers



$$RT=R1+R2 \quad Vout=\frac{R2}{RT}Vin$$

Strain Gauge Bridge



$$Vout=dV=Vleft-Vright=Vin\left[\frac{R2}{R1+R2}-\frac{Rg}{R3+Rg}\right]$$