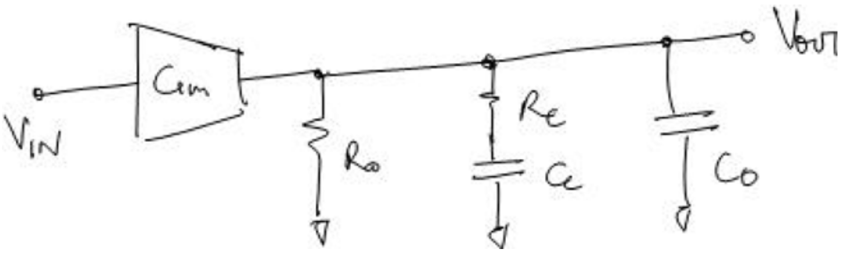
GM Amp loaded with Lead Lag network

Figure 1:



The equation is:

(%i1)
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e1: Vout=Gm*Vin/(1/Ro + 1/(Rc + 1/(s*Cc))+s*Co);
gain: rhs(ratsimp(e1/Vin));
```

(%o1) $Vout=\frac{Gm\ Vin}{Co\ s+\frac{1}{\frac{1}{Cc\ s}+Rc}+\frac{1}{Ro}}$

(%o2) $\frac{Cc\ Gm\ Rc\ Ro\ s+Gm\ Ro}{Cc\ Co\ Rc\ Ro\ s^2+((Co+Cc)Ro+Cc\ Rc)s+1}$

Zero is:

(%i3)
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zero: solve(num(gain),s);
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(%o3) $[s=-\frac{1}{Cc\ Rc}]$

Poles are:

(%i4)
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poles: solve(denom(gain),s);
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(%o4) $[s=-\frac{\sqrt{(Co^2+2\ Cc\ Co+Cc^2)Ro^2+(2\ Cc^2-2\ Cc\ Co)Rc\ Ro+Cc^2\ Rc^2}+(Co+Cc)Ro+Cc\ Rc}{2\ Cc\ Co\ Rc\ Ro}$

$, s=\frac{\sqrt{(Co^2+2\ Cc\ Co+Cc^2)Ro^2+(2\ Cc^2-2\ Cc\ Co)Rc\ Ro+Cc^2\ Rc^2}+(-Co-Cc)Ro-Cc\ Rc}{2\ Cc\ Co\ Rc\ Ro}]$

These can be approximated as: (Cc>>Co, Ro>>Rc)

(%i5)
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assume(Cc>0, Rc>0, Ro>0, Co>0);
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(%o5) $[Cc>0, Rc>0, Ro>0, Co>0]$

(%i6)
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ratsimp(factor([s=-(sqrt((Cc^2)*Ro^2+(2*Cc^2)*Rc*Ro+Cc^2*Rc^2)+(Cc)*Ro)
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(%o6) $[s=-\frac{\sqrt{Ro^2+2\ Rc\ Ro+Rc^2}+Ro}{2\ Co\ Rc\ Ro}, s=\frac{\sqrt{Ro^2+2\ Rc\ Ro+Rc^2}-Ro}{2\ Co\ Rc\ Ro}]$

This can be further reduced as:

```
(%i7) ratsimp([s=-((Ro)+Ro)/(2*Co*Rc*Ro),s=((Ro)-Ro)/(2*Co*Rc*Ro)]);
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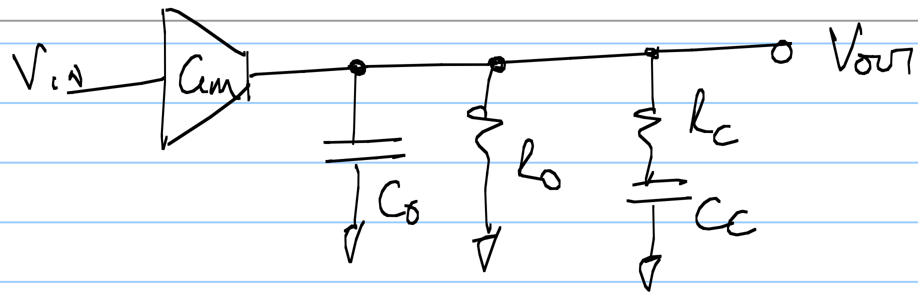
(%o7) $[s=-\frac{1}{Co\ Rc}, s=0]$

Note Title 7/5/2011



Poles:

$$s = \frac{\mp\sqrt{(C_0+C_C)^2R_0^2 + 2C_C(C_C-C_0)R_0R_C + C_C^2R_C^2} \pm \left[(C_0+C_C)R_0 + C_CR_C\right]}{2C_CC_0R_CR_0}$$

$$s \simeq \frac{\mp\sqrt{C_0^2R_0^2 - 2C_0C_CR_0R_C} \pm C_0R_0}{2C_CC_0R_CR_0}$$

$$s \simeq \mp\frac{C_0R_0\left(\left(1-\frac{2C_CR_C}{C_0R_0}\right)^{1/2} \pm 1\right)}{2C_CC_0R_CR_0}$$

$$s \simeq \mp\frac{1}{2C_CR_C}\left(1 - \frac{C_CR_C}{C_0R_0} \pm 1\right)$$

$$s \simeq -\frac{1}{C_CR_C} \mp \frac{1}{2C_0R_0}, \quad \frac{1}{2C_CR_C}\left(-\frac{C_CR_C}{C_0R_0}\right)$$

$$s \simeq -\frac{1}{C_CR_C}, \quad -\frac{1}{2C_0R_0}$$

Hence zero & pole are same!