

$$\|(Z1, Z2) := \frac{Z1 \cdot Z2}{Z1 + Z2}$$

### Definition for Bode plots:

$$sf(f) := 2j \cdot \pi f$$

$$\theta(Fn) := \arg(Fn) \cdot \frac{180}{\pi}$$

$$dB(Fn) := 20 \cdot \log(|Fn|)$$

```

bode(TF, s) :=
  mag ← 20 · log(|TF(s)|)
  phz ← arg(TF(s)) · 180 / π
  jmp ← 1
  for n ∈ 1 .. last(s) - 1
    diff ← phzn+1 - phzn
    if (diff > 180) + (diff < -180)
      posjmp ← n + 1
      shjmp ← -360 if diff > 0
              360 otherwise
      jmp ← jmp + 1
  for x ∈ 1 .. jmp - 1 if jmp > 1
    for z ∈ posx .. last(s)
      phzz ← phzz + shx
  (mag)
  (phz)
  
```

## Amplifier Gain calculation

fields which are highlighted in yellow are user inputs

fields which are highlighted in Blue are calculation results

Select frequency range

start := 10Hz

end := 100kHz

nmpts := 5000

### Amplifier bandwidth factors :

GBP := 1000kHz

LPF := 300Hz

$R_1 := 1k\Omega$

$C_1 := 100nF$

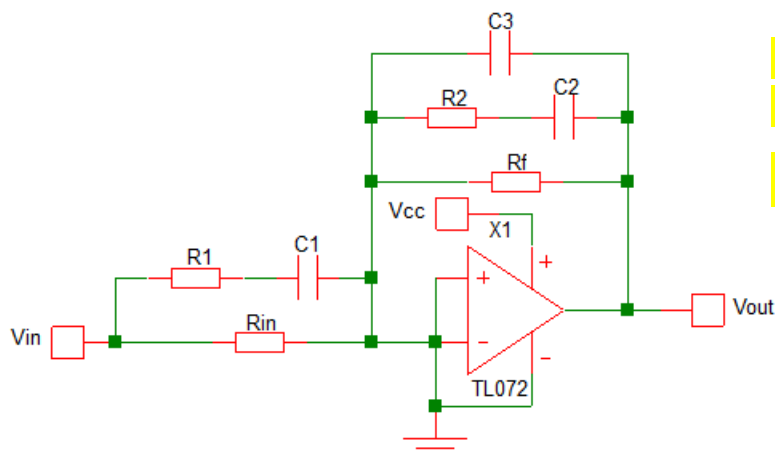
$R_{in} := 1k\Omega$

$C_3 := 47nF$

$R_2 := 1k\Omega$

$C_2 := 470nF$

$R_f := 10^{99} k\Omega$



$$Z_1(s) := R_1 + \frac{1}{sC_1}$$

$$Z_2(s) := R_2 + \frac{1}{sC_2}$$

$$Z_{in}(s) := R_{in} \parallel Z_1(s)$$

$$Z_{fb}(s) := R_f \parallel \left[ Z_2(s) \parallel \left( \frac{1}{s \cdot C_3} \right) \right]$$

$$G_{EAideal}(s) := \frac{Z_{fb}(s)}{Z_{in}(s)}$$

### Nonideal OP-Amp effects : Finite open loop gain

$$\beta(s) := \frac{1}{1 + |G_{EAideal}(s)|}$$

### Finite open loop gain:

$$A_{vo}(s) := \frac{GBP}{LPF} \cdot \frac{1}{\left(1 + \frac{s}{2 \cdot \pi \cdot LPF}\right) \cdot \left(1 + \frac{s}{2 \cdot \pi \cdot GBP}\right)}$$

### nonideal error amplifier gain :

$$G_{EA}(s) := G_{EAideal}(s) \cdot \frac{1}{1 + \frac{1}{A_{vo}(s) \cdot \beta(s)}}$$

$$\begin{pmatrix} Gea_{mag} \\ Gea_{phs} \end{pmatrix} := \text{bode}(G_{EA}, sn)$$

$$\begin{pmatrix} Gea_{ideal_{mag}} \\ Gea_{ideal_{phs}} \end{pmatrix} := \text{bode}(G_{EAideal}, sn)$$

$$\begin{pmatrix} Avo_{mag} \\ Avo_{phs} \end{pmatrix} := \text{bode}(A_{vo}, sn)$$

