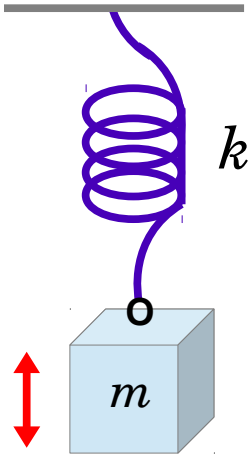
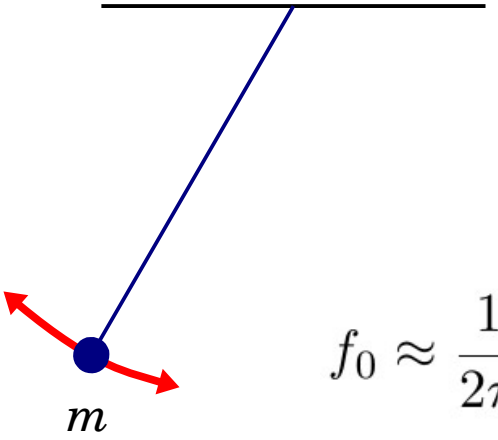
Lab 10: Oscillators

Oscillators



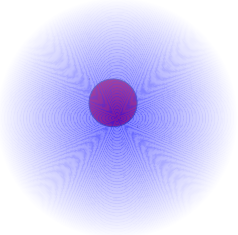
$$f_0 = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$



$$f_0 \approx \frac{1}{2\pi}\sqrt{\frac{g}{L}}$$

Oscillators

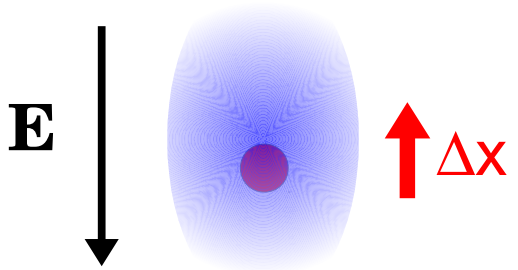
Lorentz Model of the atom



Nucleus + electron cloud

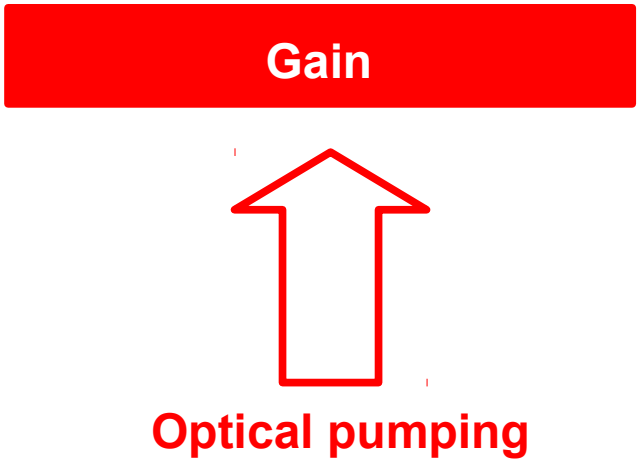
Oscillators

Lorentz Model of the atom

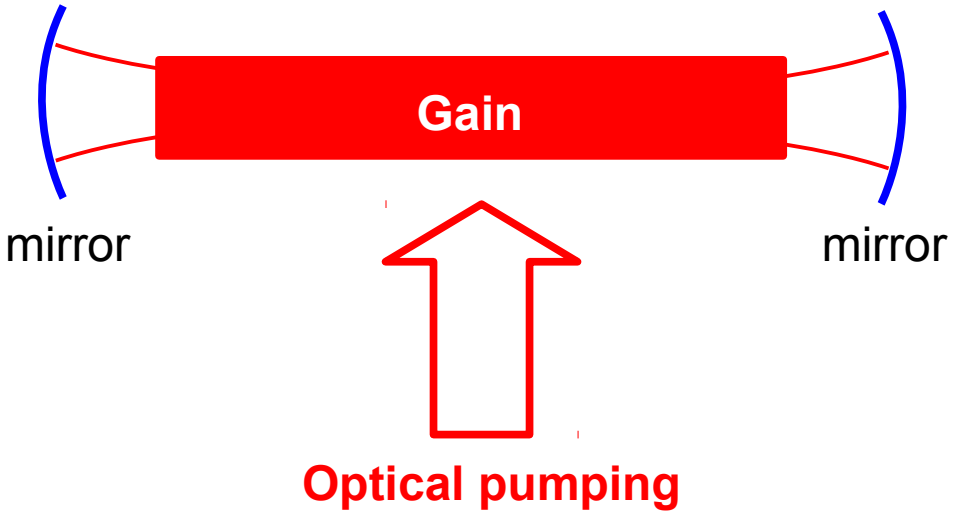


Electric-field induces a dipole moment

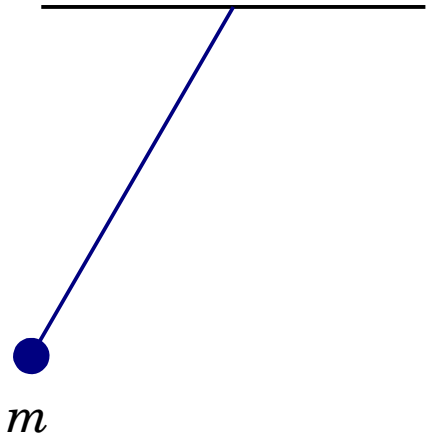
Laser Oscillators:
Optical gain inside a feedback cavity



Laser Oscillators:
Optical gain inside a feedback cavity

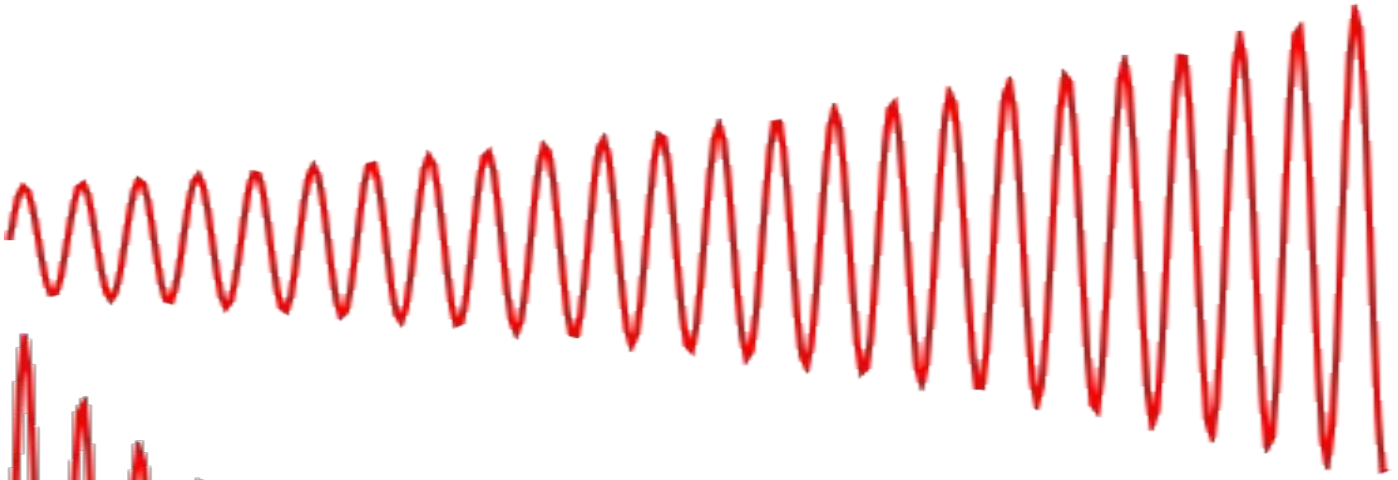


Driven oscillations: Pendulum example

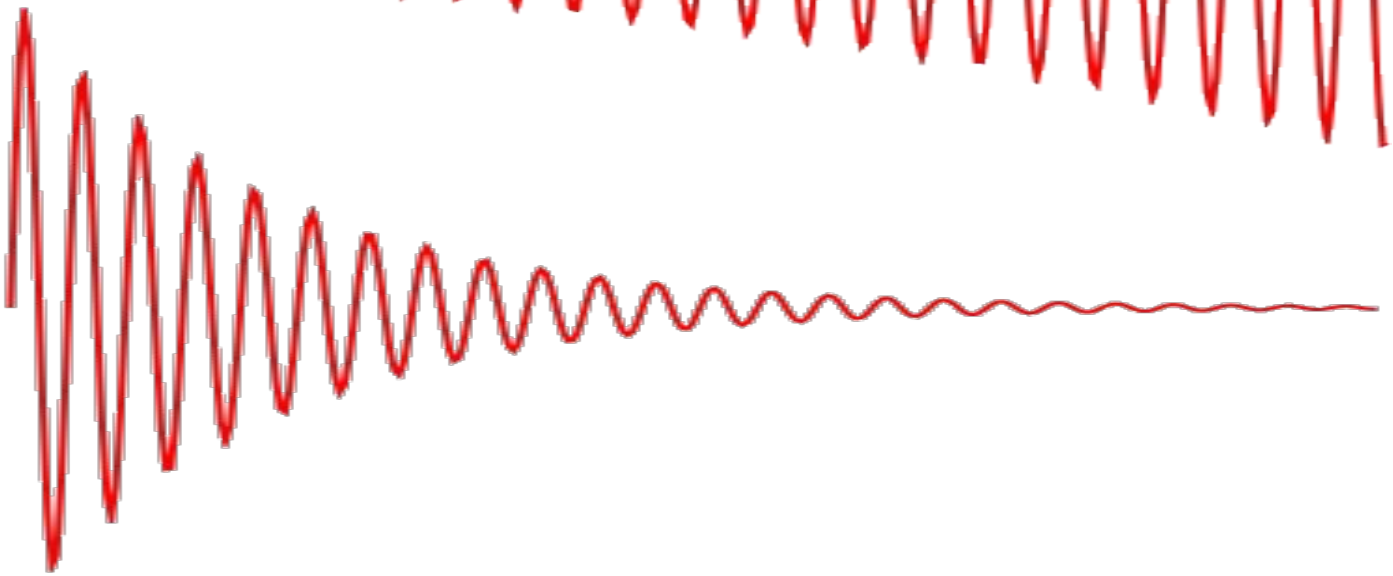


$$f_0 \approx \frac{1}{2\pi}\sqrt{\frac{g}{L}}$$

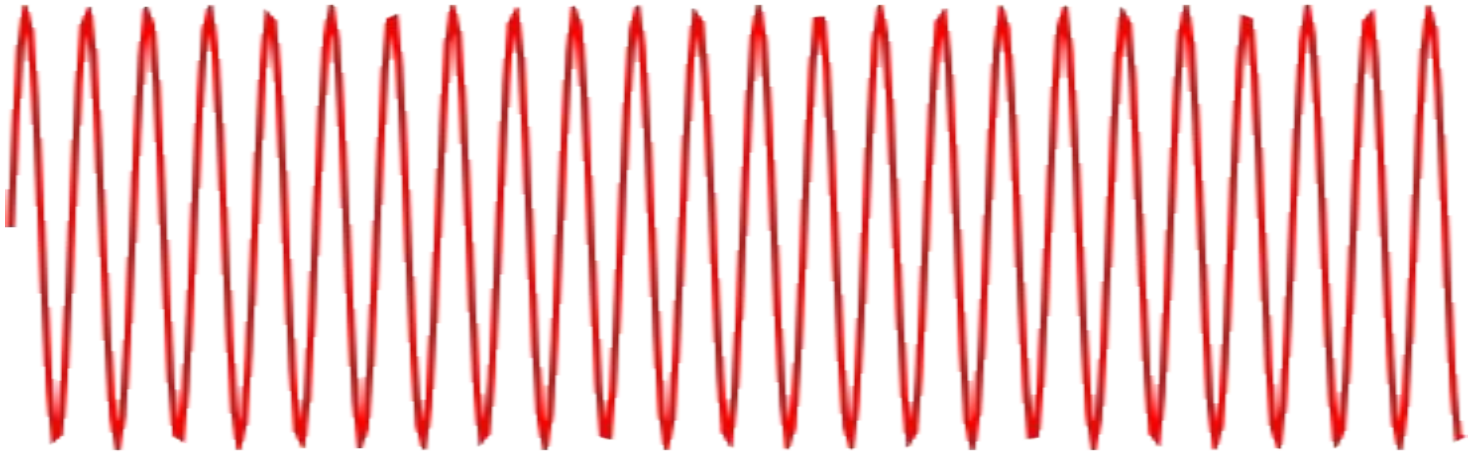
Under-damped driven oscillations



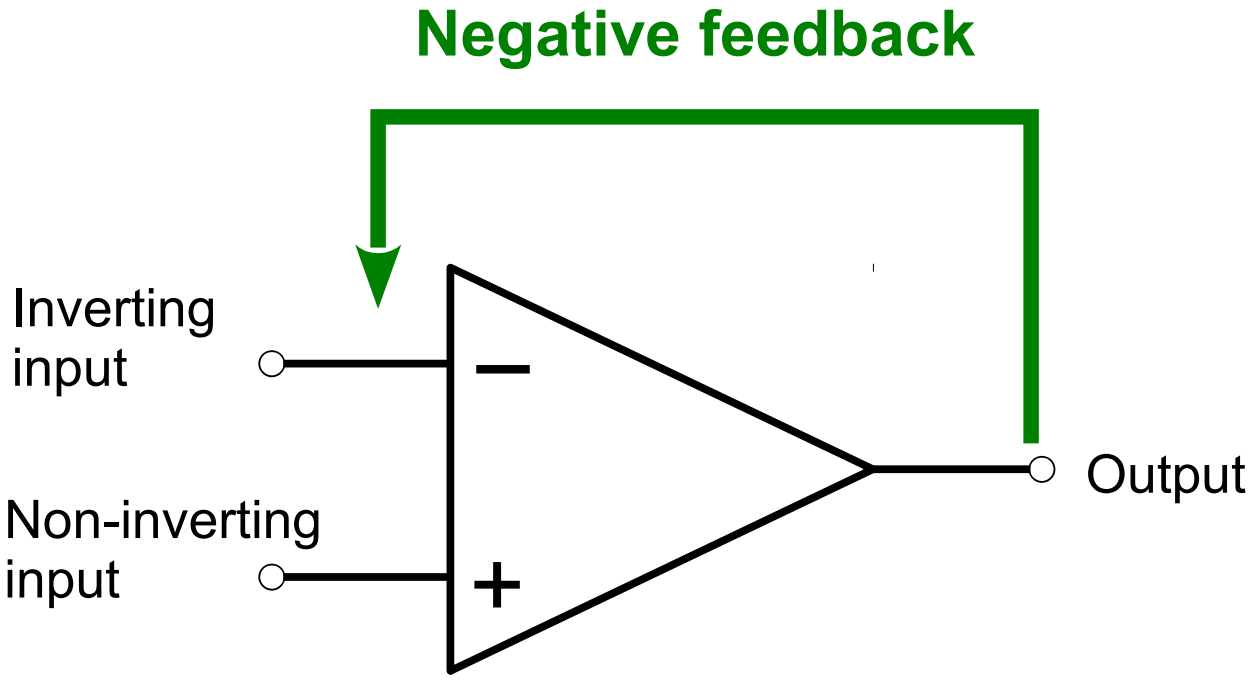
Damped oscillations



Stable oscillations



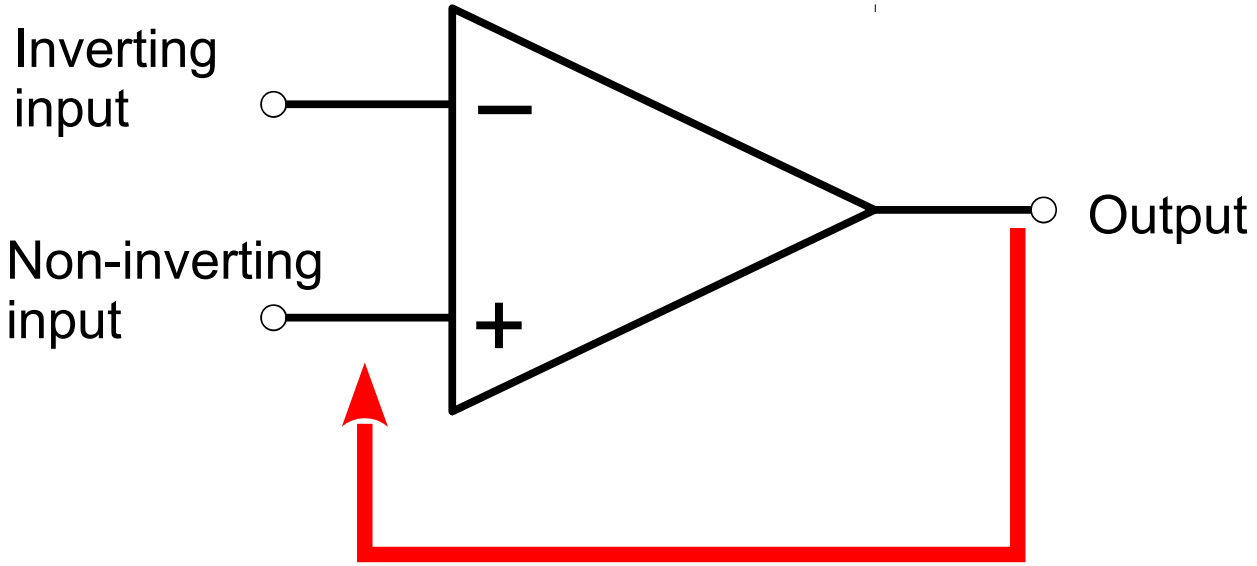
FEEDBACK: Sending a portion of the output back to the input



Stabilizes the output of an amplifier

FEEDBACK: Sending a portion of the output back to the input

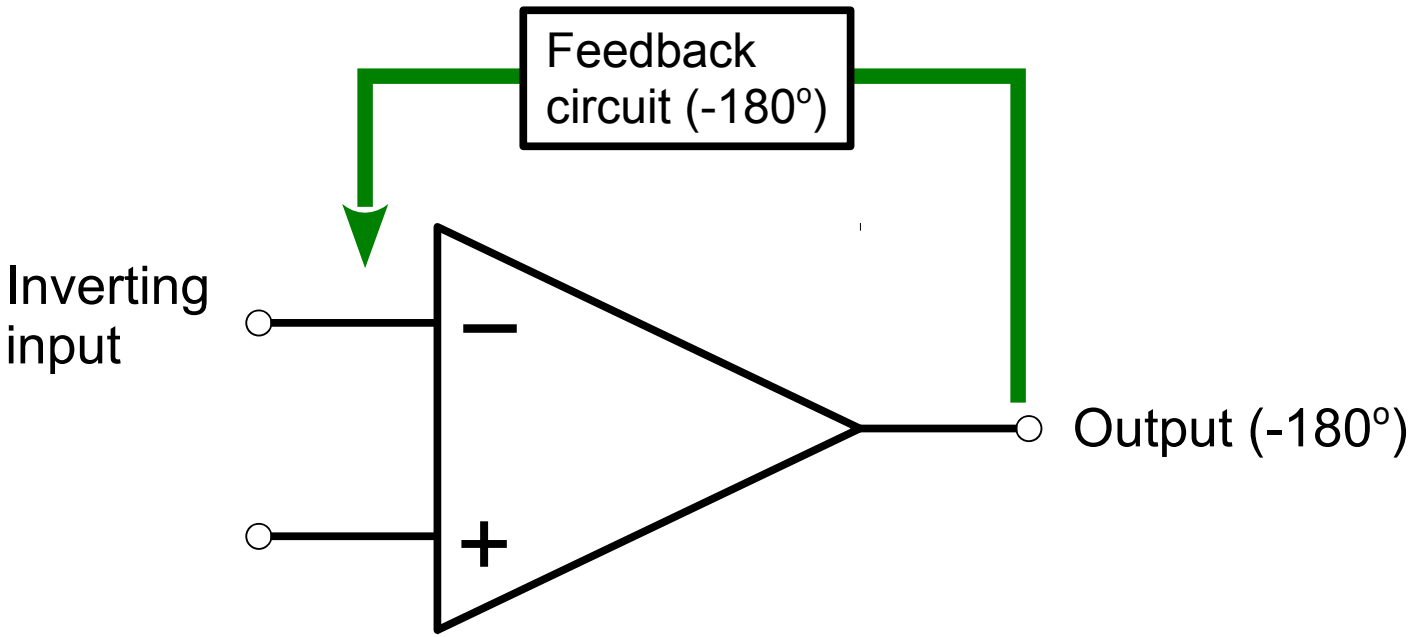
Positive feedback



Runaway amplification – Oscillation

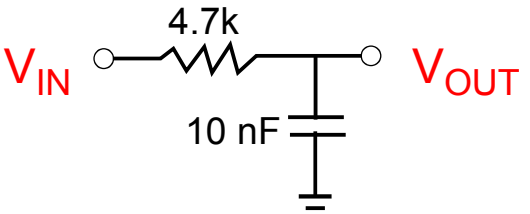
Stable oscillations using the inverting input

1) Net gain is 1.
2) Phase-shift between input-output is 0.

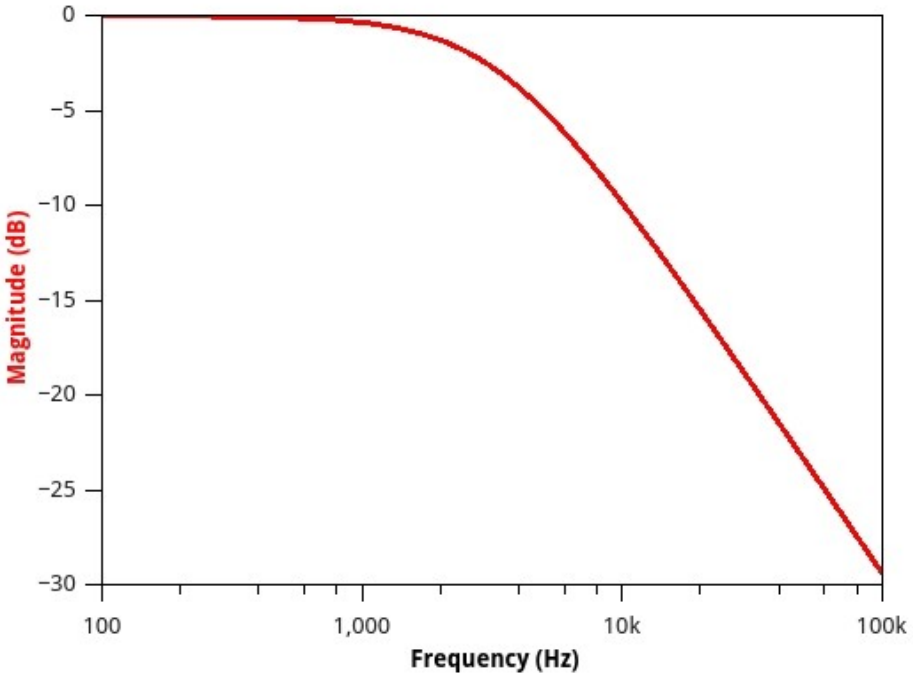


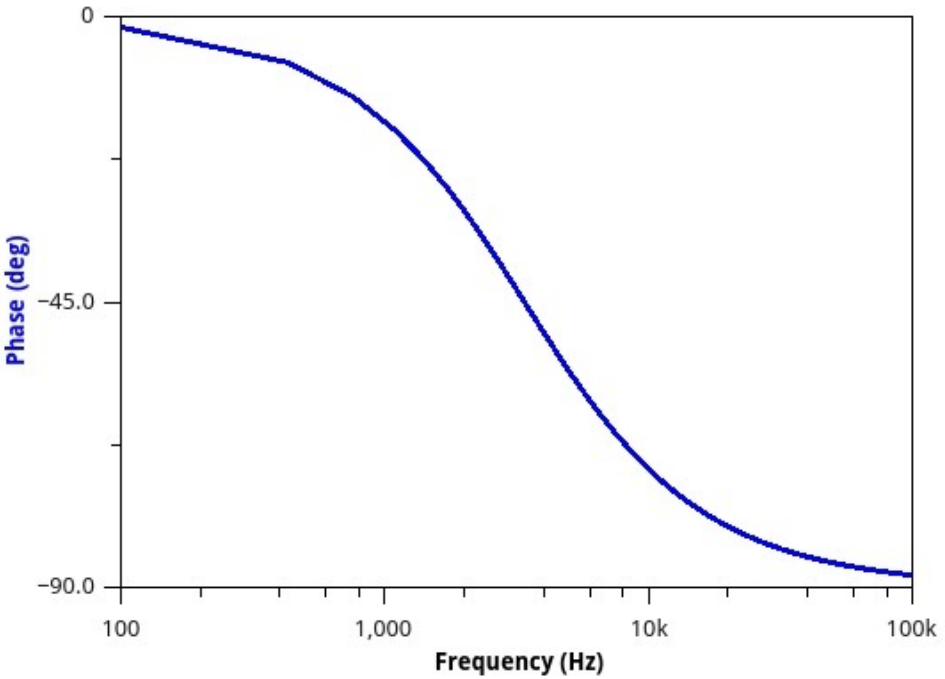
Single RC filter provides phase shift but not enough for oscillation

Need –180°

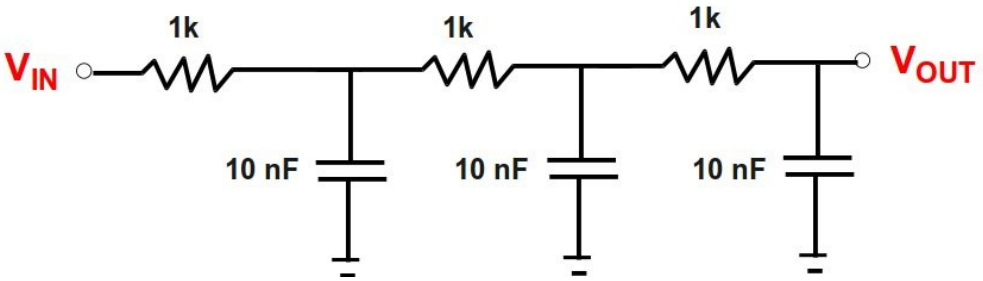


Bode plots of Magnitude and Phase for single RC low-pass filter

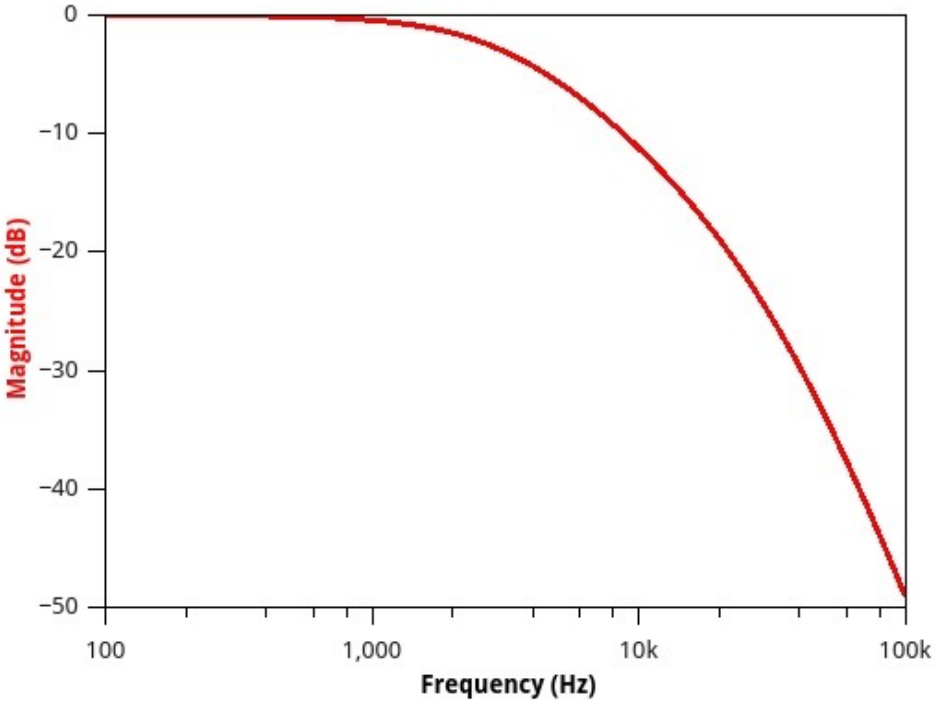


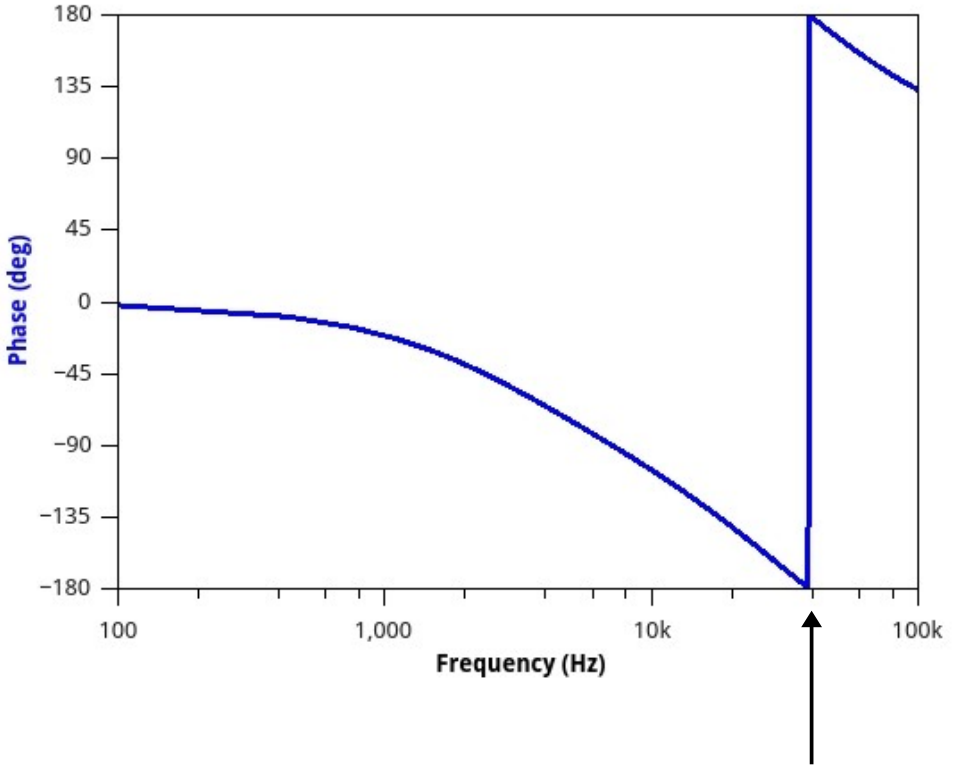


3-Stage RC network provides adequate feedback phase-shift for oscillations



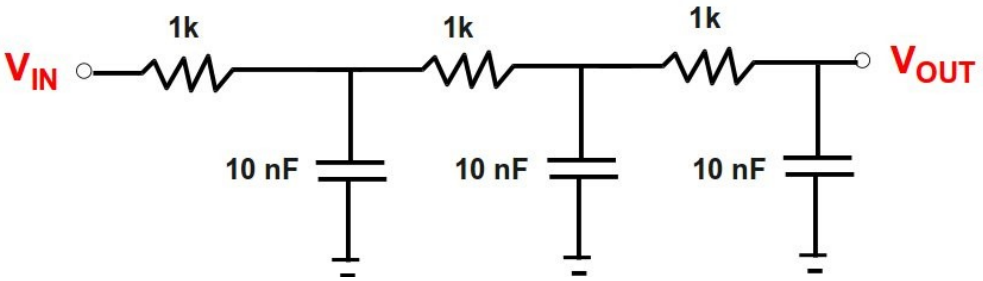
Bode plots of Magnitude and Phase for 3-stage RC low-pass filter



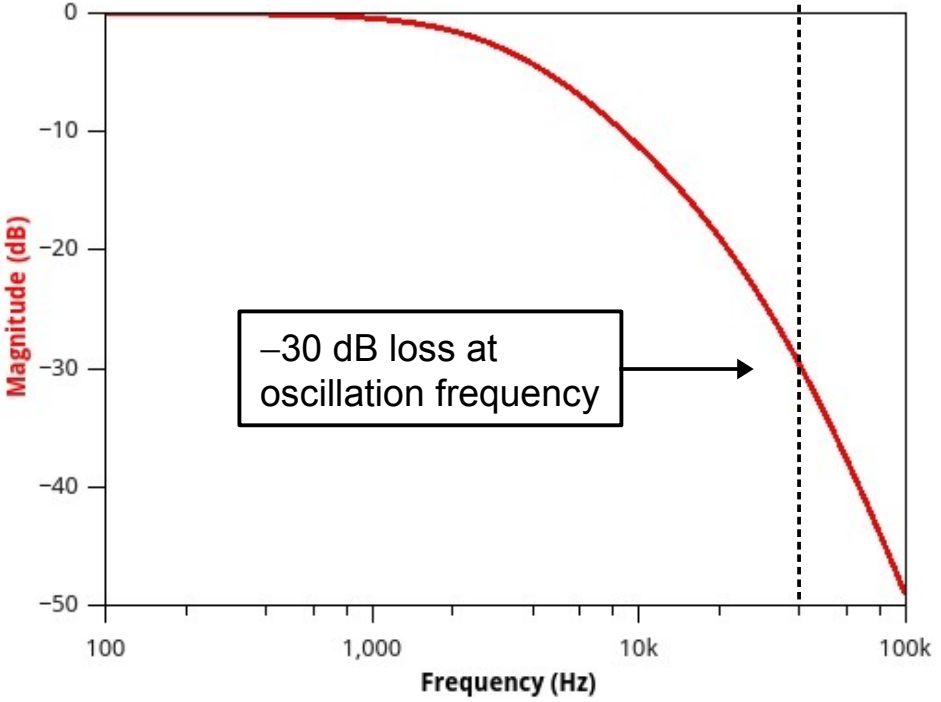


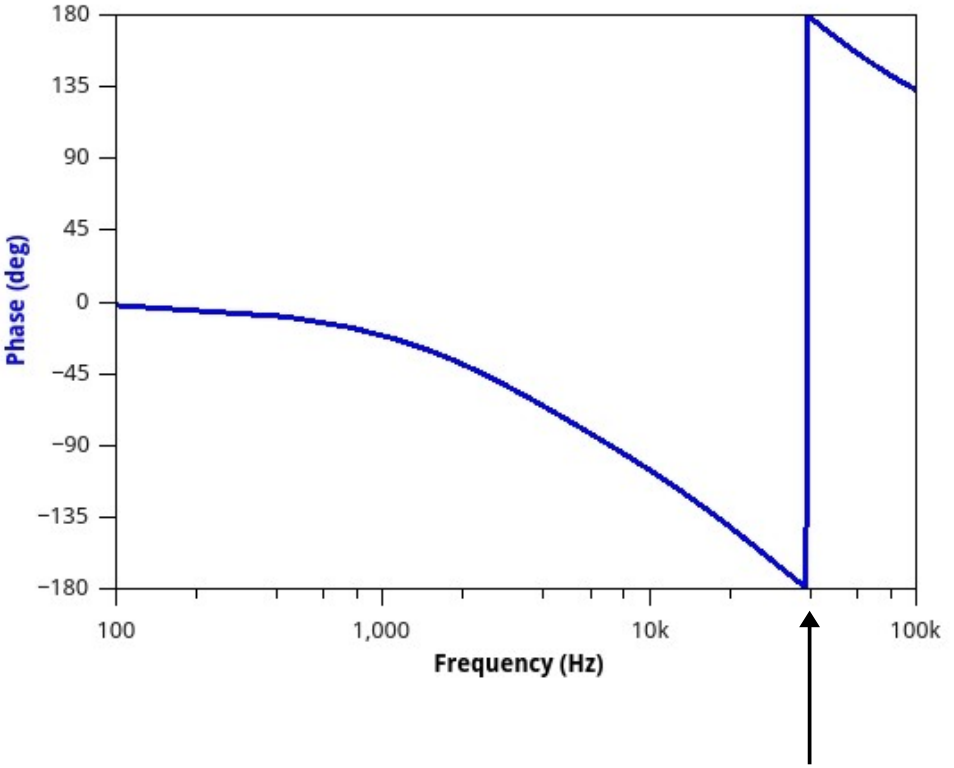
Oscillation frequency

3-Stage RC network provides adequate feedback phase-shift for oscillations



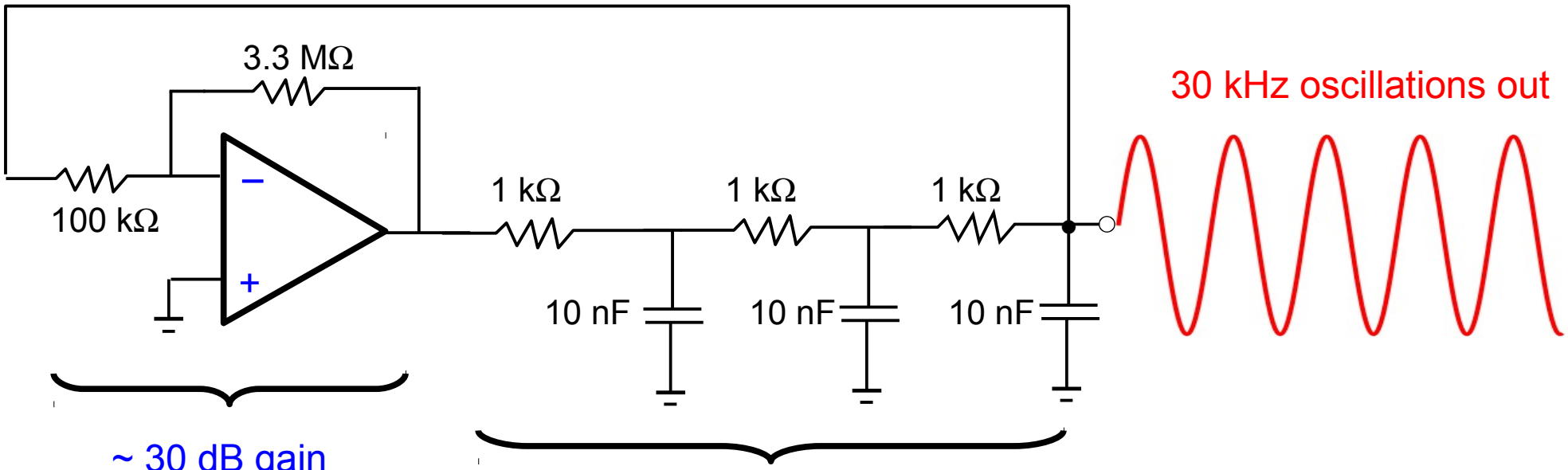
Bode plots of Magnitude and Phase for 3-stage RC low-pass filter



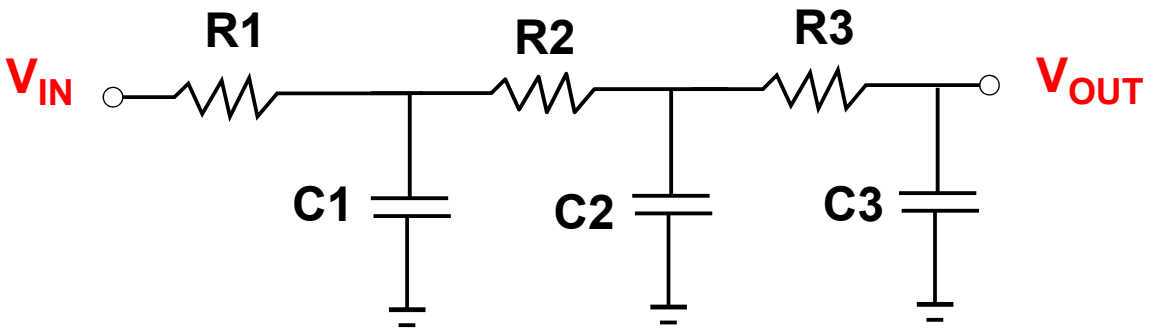


Oscillation frequency

Phase-shift oscillator



Analysis of feedback circuit is difficult because of loading



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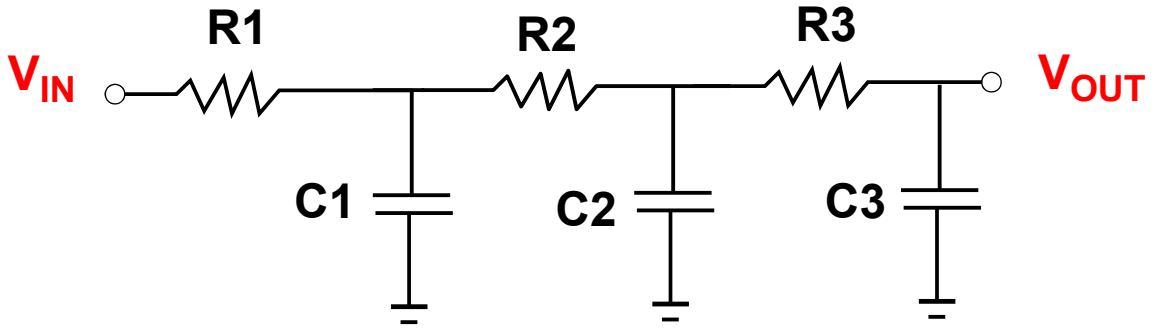
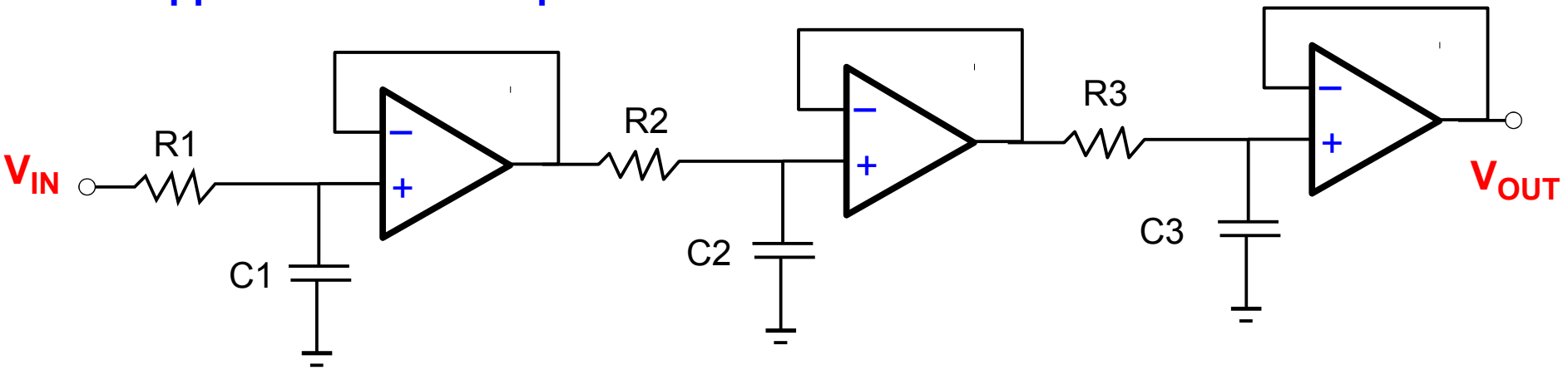
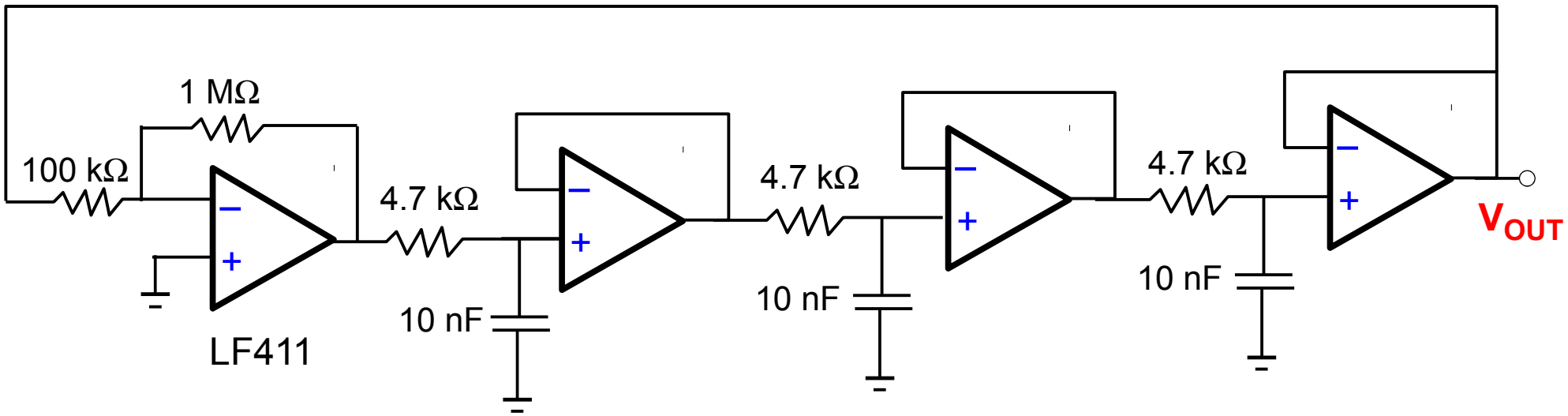


Better approach: Buffer amplifiers



$$\frac{V_{OUT}}{V_{IN}} = \left[\frac{1}{1+j\omega R1C1}\right]\left[\frac{1}{1+j\omega R2C2}\right]\left[\frac{1}{1+j\omega R3C3}\right]$$

Buffered phase-shift oscillator



Phase-shift oscillator is just one of many ways to build electronic oscillators

Feedback oscillators:

- **Phase-shift**
- **Wien bridge**
- **Resonant LC**

Negative resistance oscillators

- **Used in microwave electronics**

Relaxation oscillators

Voltage-controlled oscillators