Electronic Circuits – EE359A

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Filters and Tuned Amplifiers

Second order LCR resonator

Second order Active Filters based on Inductor Replacement

Signal Generators

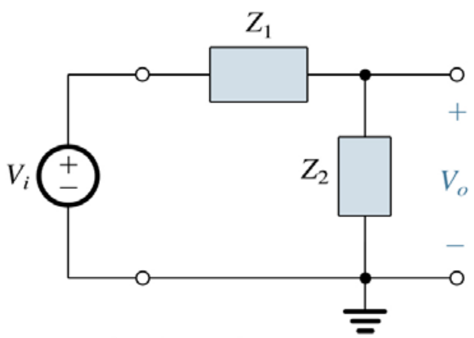
Oscillators

Second Order LCR Resonator

- LCR Resonator

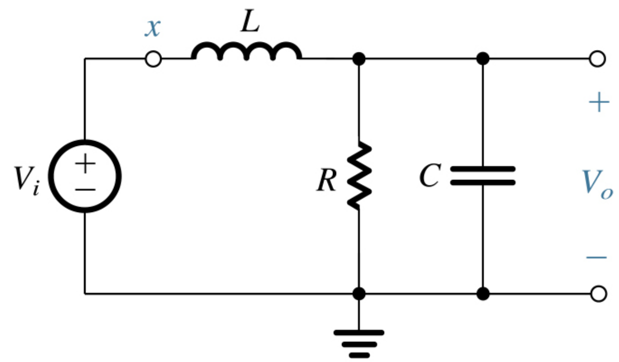
$$\frac{V_0}{I} = \frac{1}{Y} = \frac{1}{1/sL + sC + 1/R}$$
$$= \frac{s/C}{s^2 + s(1/CR) + 1/LC}$$

$$\omega_0^2 = 1/LC$$
$$\omega_0 / Q = 1/CR$$
$$\omega_0 = 1/\sqrt{LC}$$
$$Q = \omega_0 CR$$



(a) General structure

- Excite parallel LCR resonator
  - Determine natural modes (I.e. poles of response function)



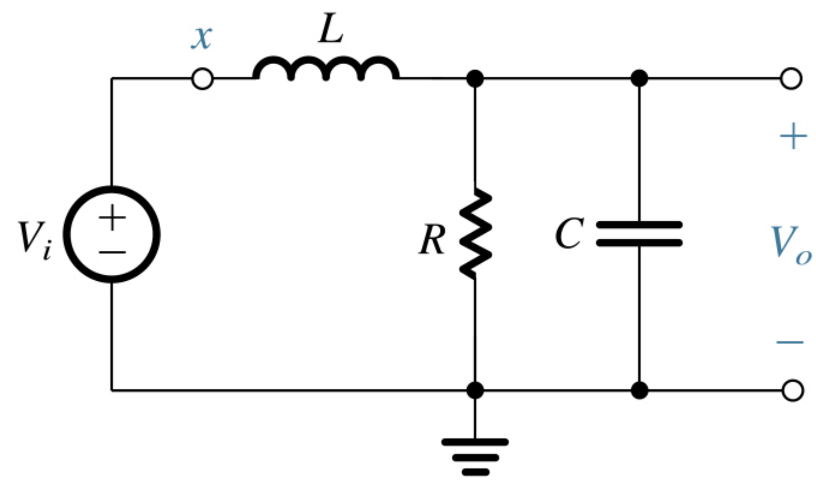
(b) LP

Transmission Zeros LPF

- Where to inject iput signal V_i ?

$$T(s) = \frac{V_0(s)}{V_i(s)} = \frac{Z_2(s)}{Z_1(s) + Z_2(s)}$$

- Transmission zeros are when $Z_2(s)$ are zero (if Z_1



(b) LP

Realization of Low Pass Function

- Transmission zeros are when series impedance becomes infinite.

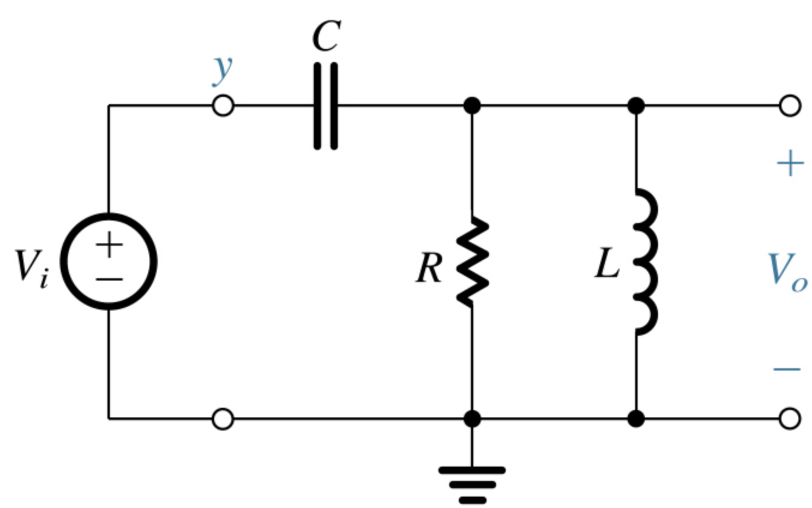
$$sL \to \infty \Rightarrow s \to \infty \Rightarrow \frac{1}{sC + 1/R} \to 0$$

$$T(s) = \frac{V_0}{V_i} = \frac{Z_2}{Z_1 + Z_2} = \frac{Y_1}{Y_1 + Y_2} = \frac{1/sL}{1/sL + sC + 1/R}$$

High Pass Filter

- Use the series capacitor. Transmission zero at s=0 (dc), shunt inductor is a tranmission zero at s=0.

$$T(s) = \frac{V_0}{V_i} = \frac{a_2 s^2}{s^2 + s(\omega_0 / Q) + \omega_0^2}$$

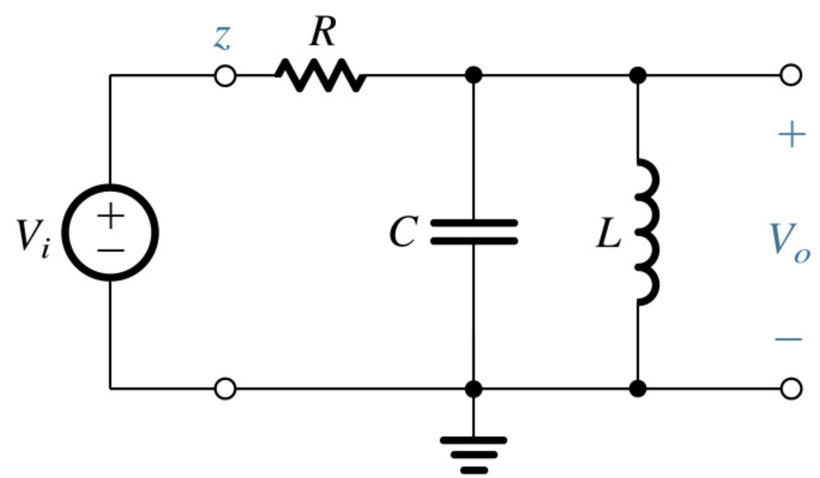


(c) HP

Bandpass Filter

- Zero at s=0 due to shunt inductor, s=infinity due to shunt capacitor.

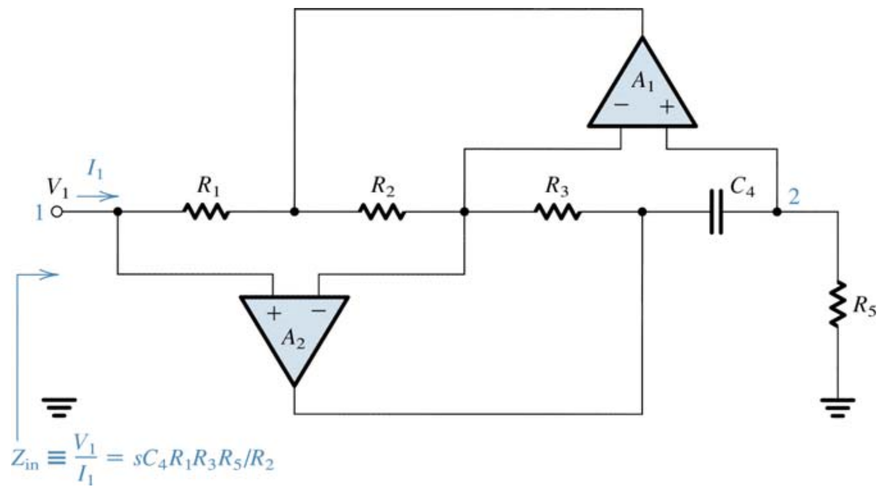
$$T(s) = \frac{V_0}{V_i} = \frac{s(1/CR)}{s^2 + s(1/CR) + 1/LC}$$

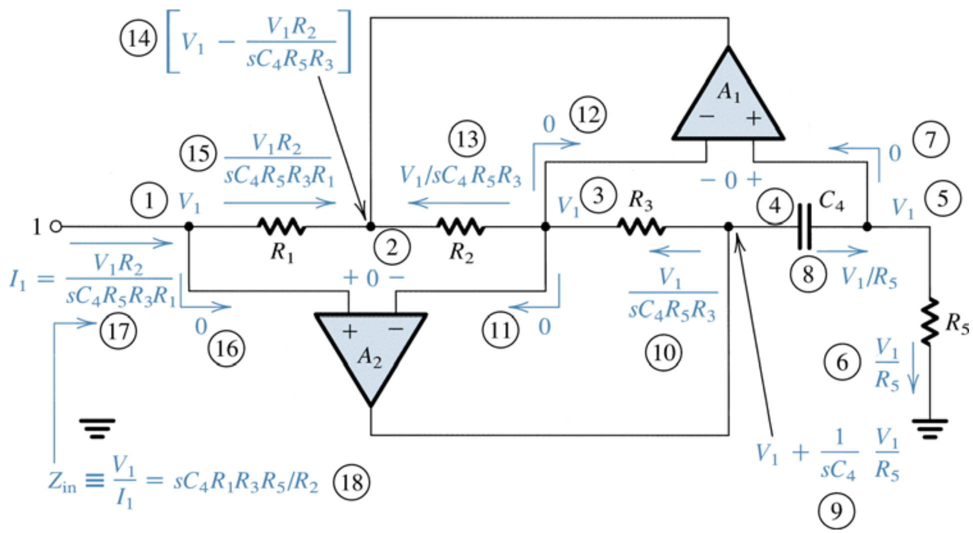


(d) BP

Inductance Simulation

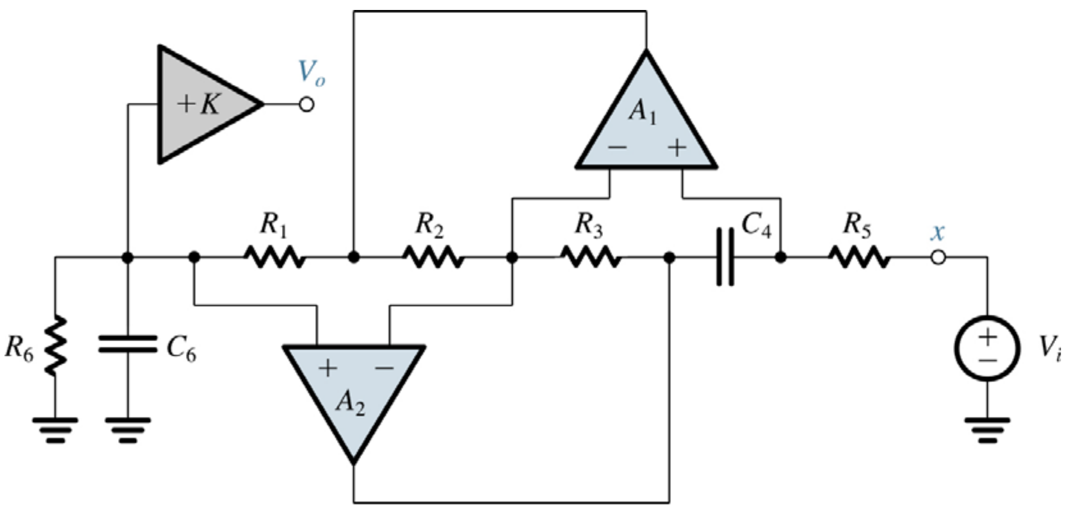
- Use opamps instead of inductor!



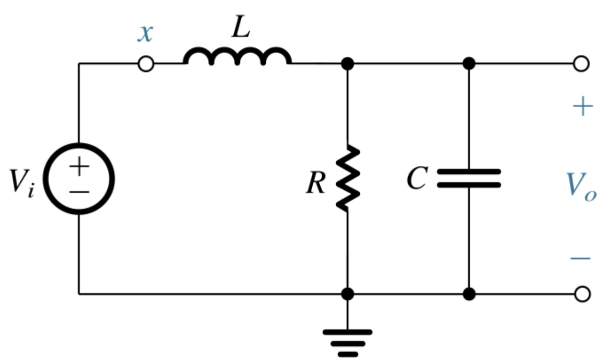


Low Pass Filter

$$T(s)=\frac{V_0(s)}{V_i(s)}=\frac{Z_2(s)}{Z_1(s)+Z_2(s)}$$



(a) LP

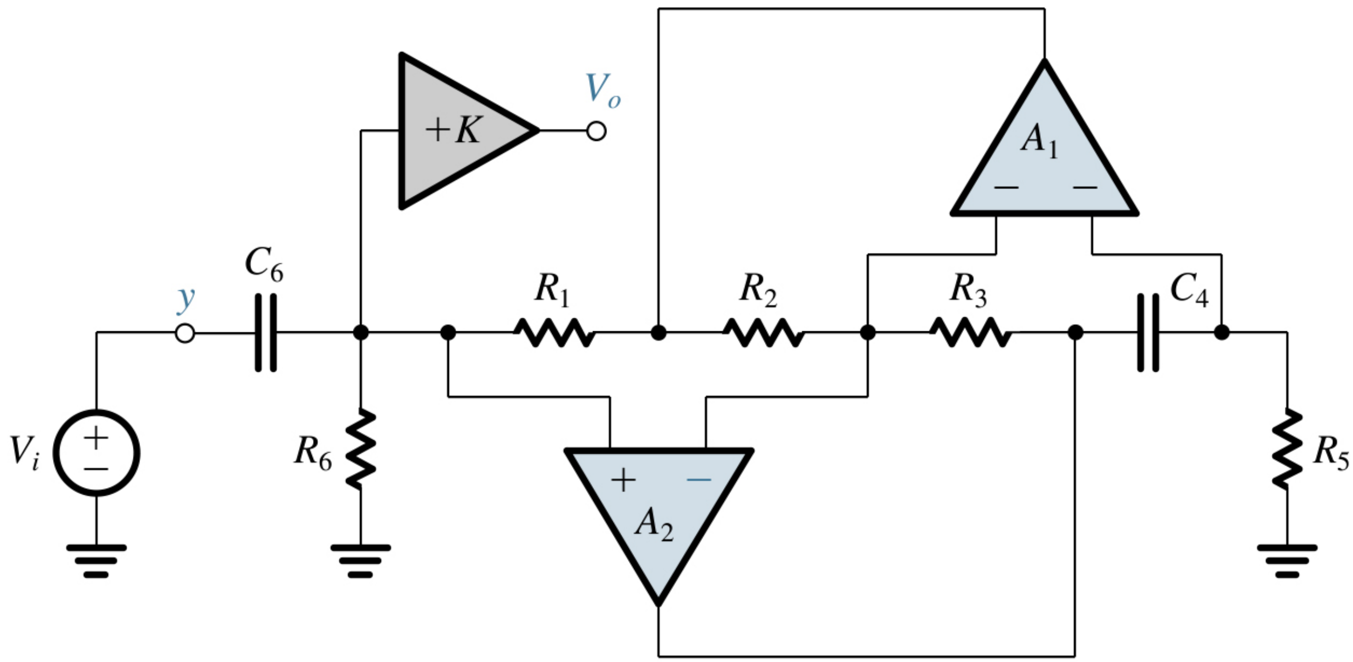


(b) LP

$$T(s)=\frac{V_0}{V_i}=\frac{Z_2}{Z_1+Z_2}=\frac{Y_1}{Y_1+Y_2}=\frac{1/sL}{1/sL+sC+1/R}$$

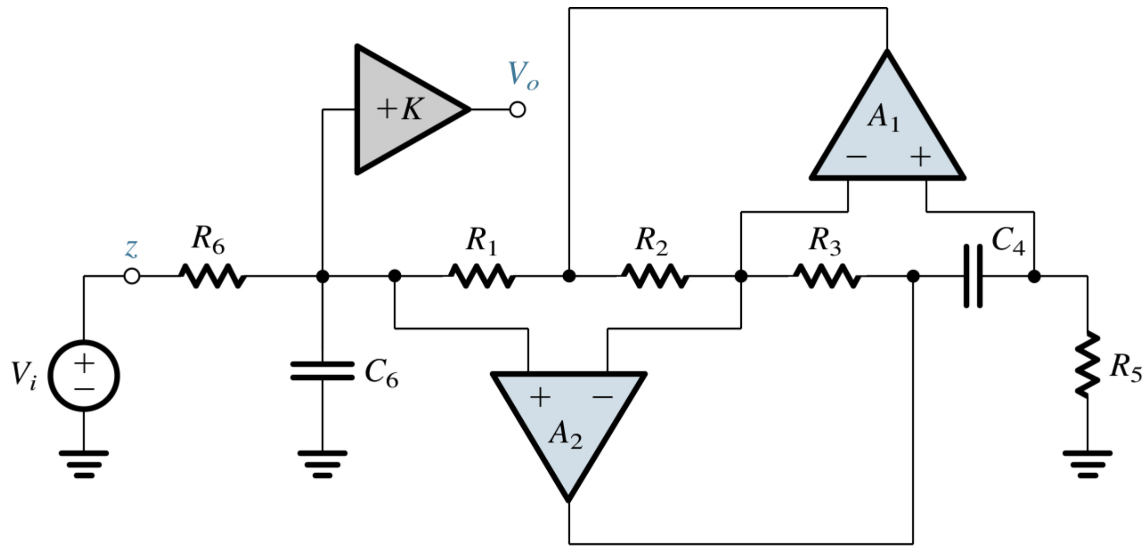
High Pass Filter

- $$T(s) = \frac{V_0}{V_i} = \frac{a_2 s^2}{s^2 + s(\omega_0 / Q) + \omega_0^2}$$



(b) HP

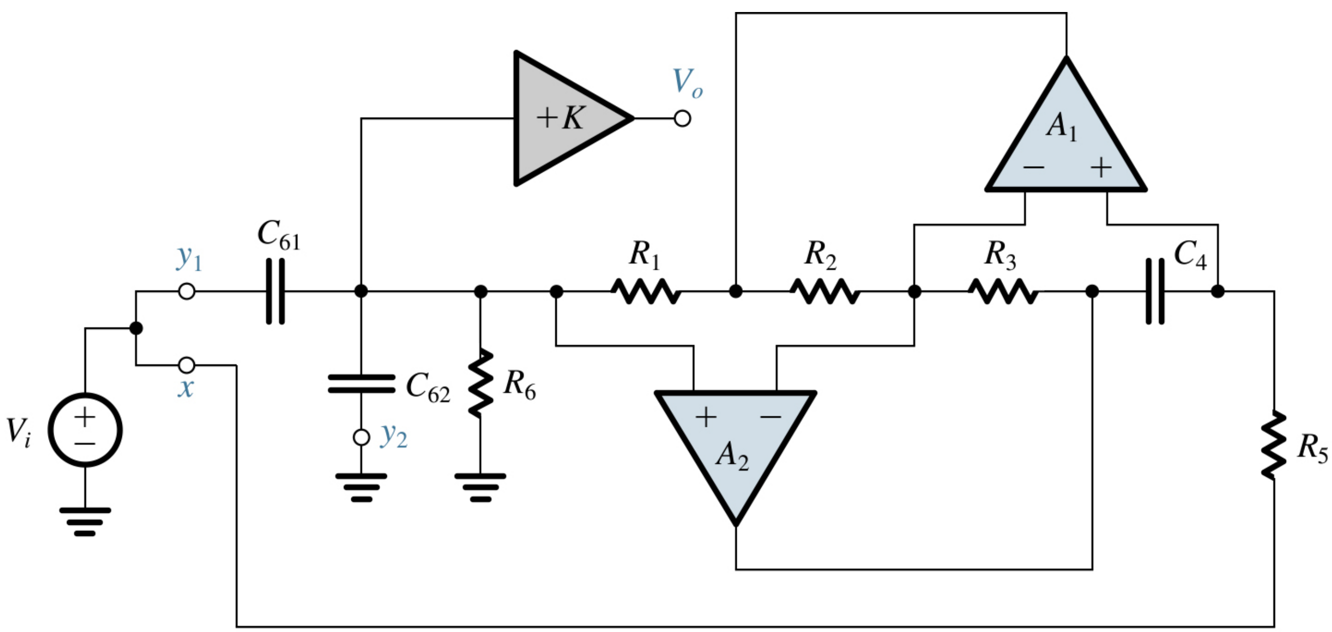
Bandpass Filter

- 

(c) BP

$$T(s) = \frac{V_0}{V_i} = \frac{s(1/CR)}{s^2 + s(1/CR) + 1/LC}$$

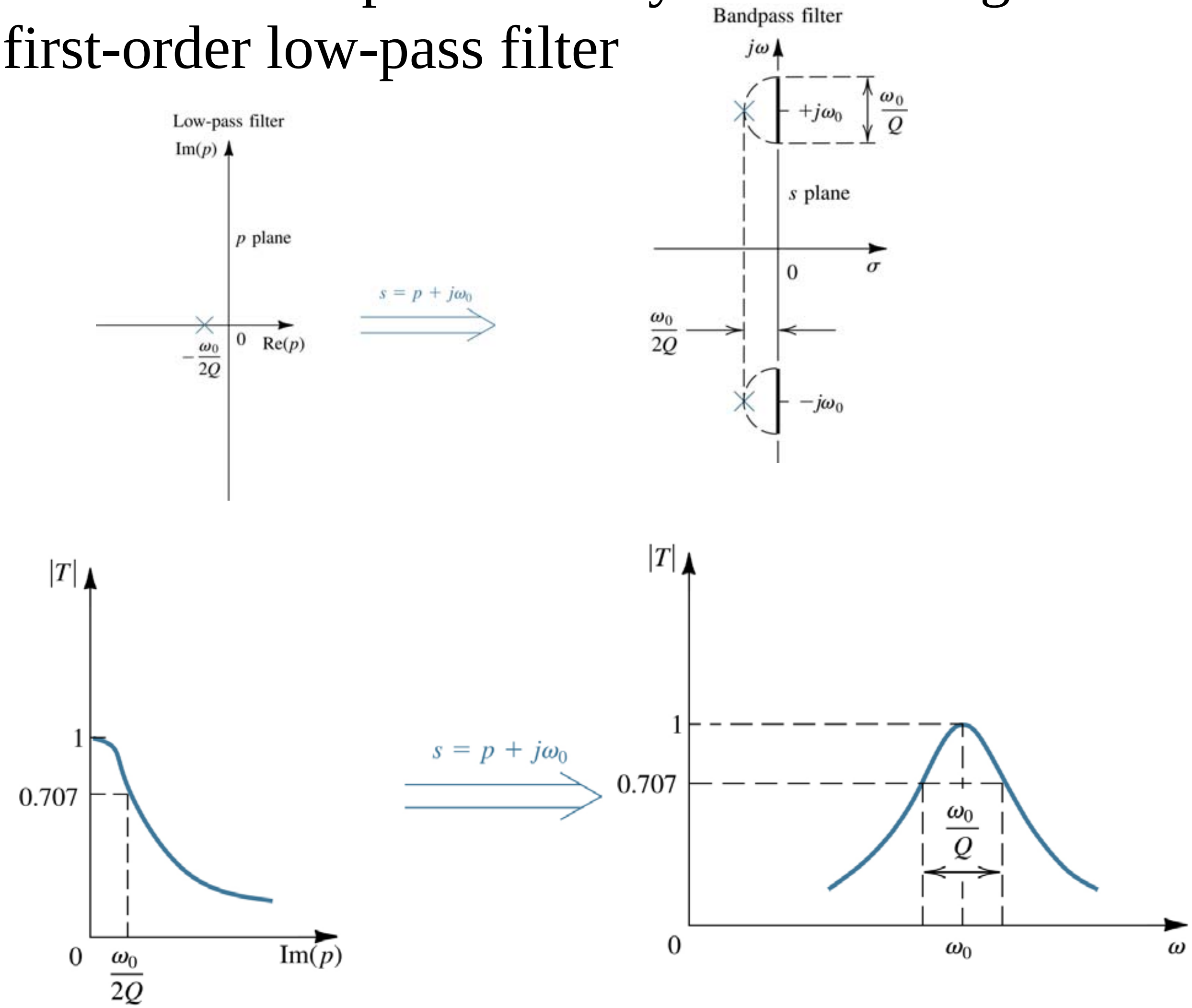
Low Pass Notch filter

- 

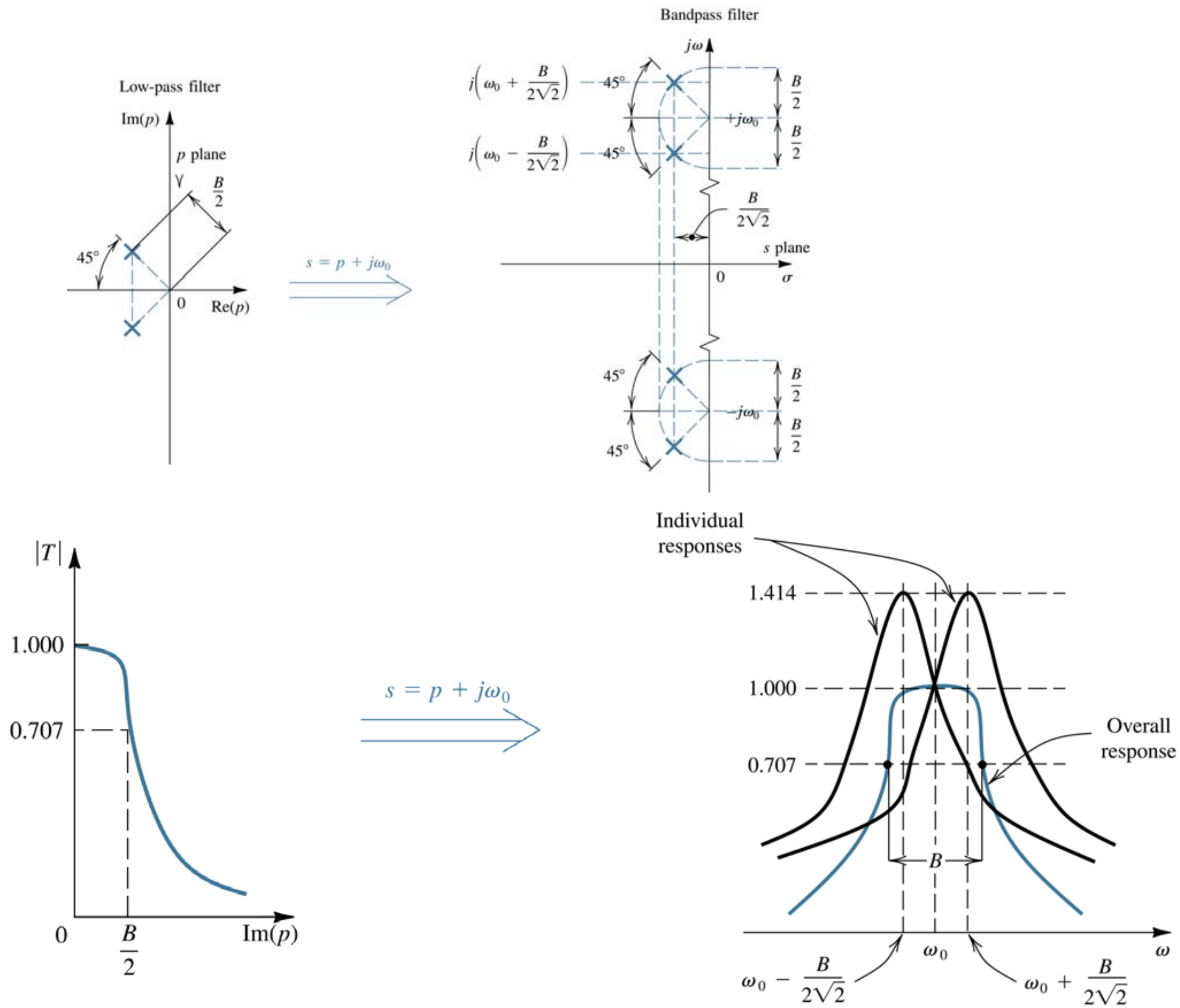
(e) LPN, $\omega_n \geq \omega_0$

Second-order narrow-band bandpass filter by transforming a first-order low-pass filter

Second-order narrow-band bandpass filter by transforming a first-order low-pass filter. **(a)** Pole of the first-order filter in the s-plane. **(b)** Applying the transformation $s = p + j\omega_0$ and adding a complex conjugate pole results in the poles of the second-order bandpass filter. **(c)** Magnitude response of the firs-order low-pass filter. **(d)** Magnitude response of the second-order bandpass filter.

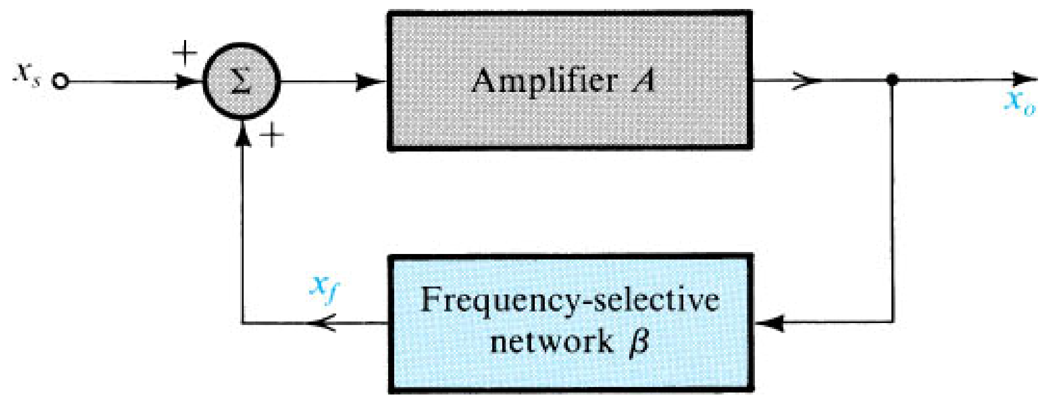


Poles and the frequency response of a fourth-order stagger-tuned narrow-band bandpass amplifier by transforming a second-order low-pass .



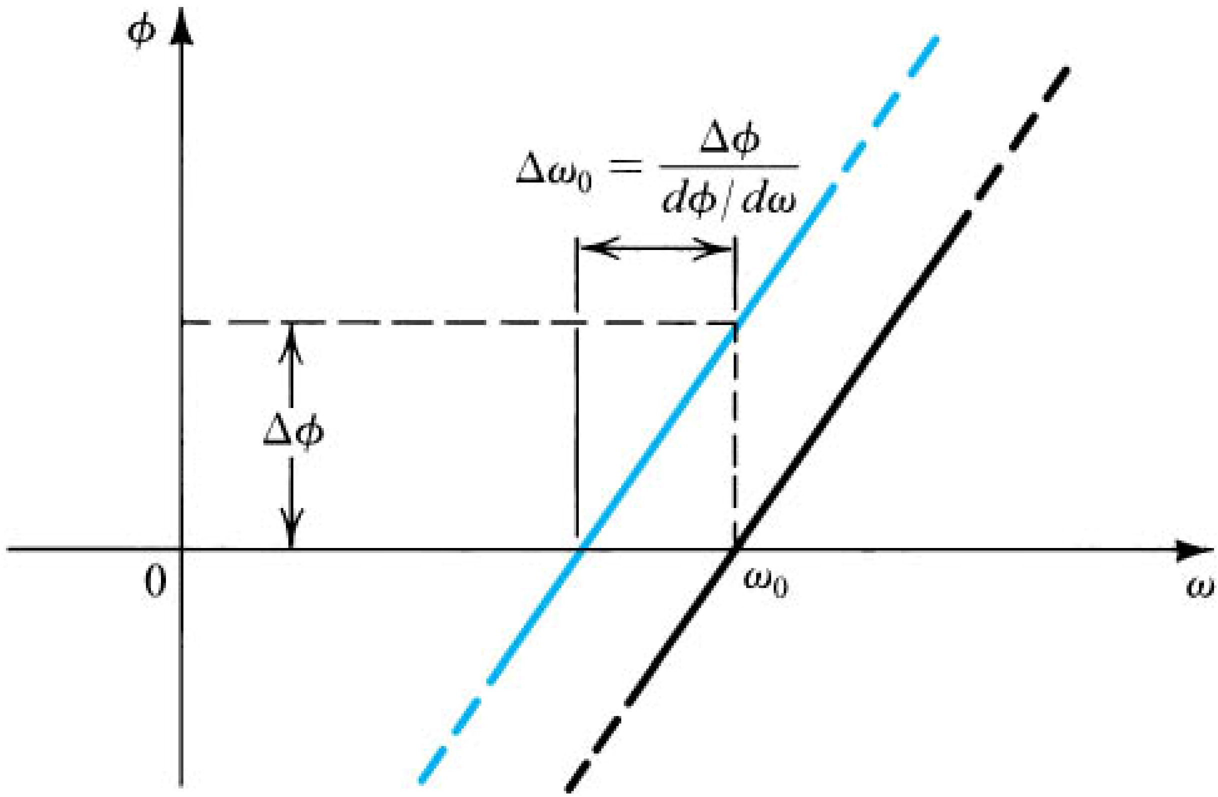
SIGNAL GENERATORS /OSCILLATORS

A positive-feedback loop is formed by an amplifier and a frequency-selective network

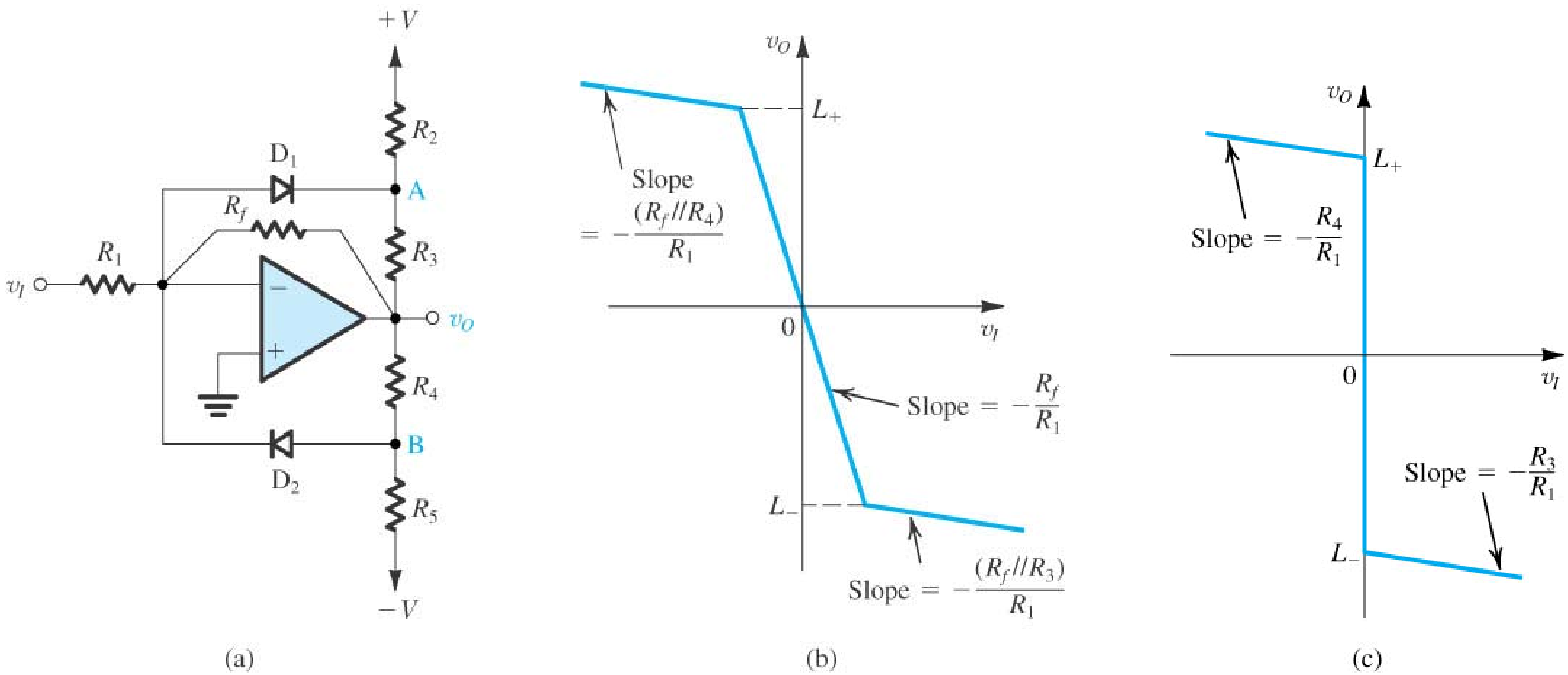


In an actual oscillator circuit, no input signal will be present

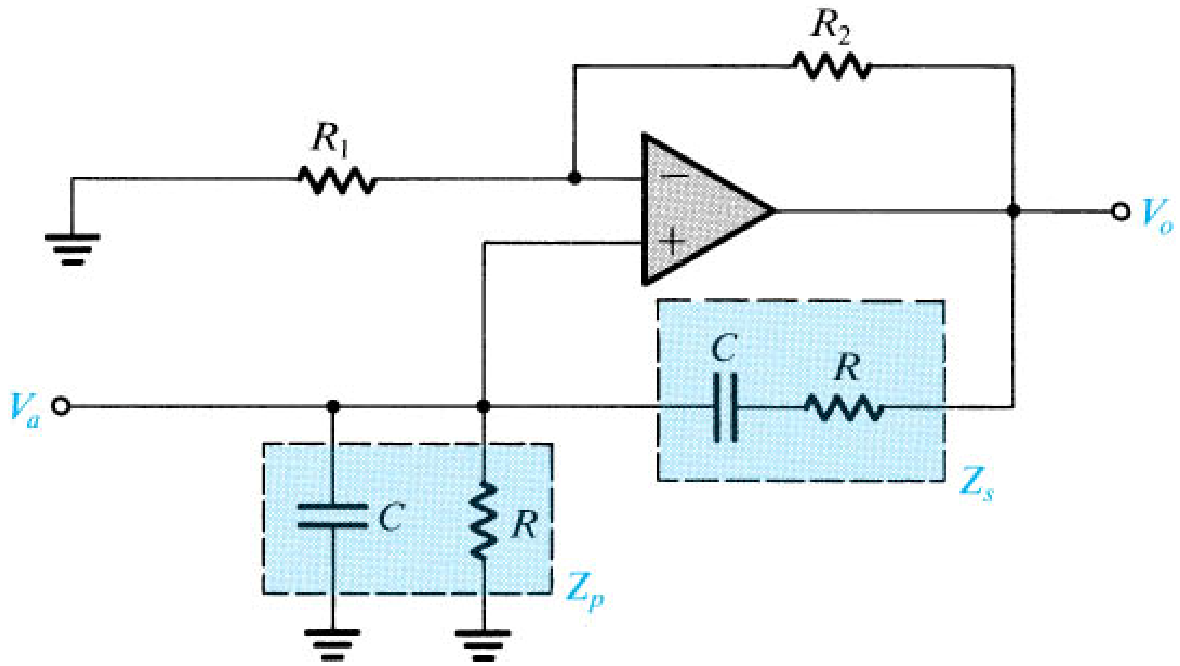
Oscillator-frequency stability



Limiter Ckt→ Comparator



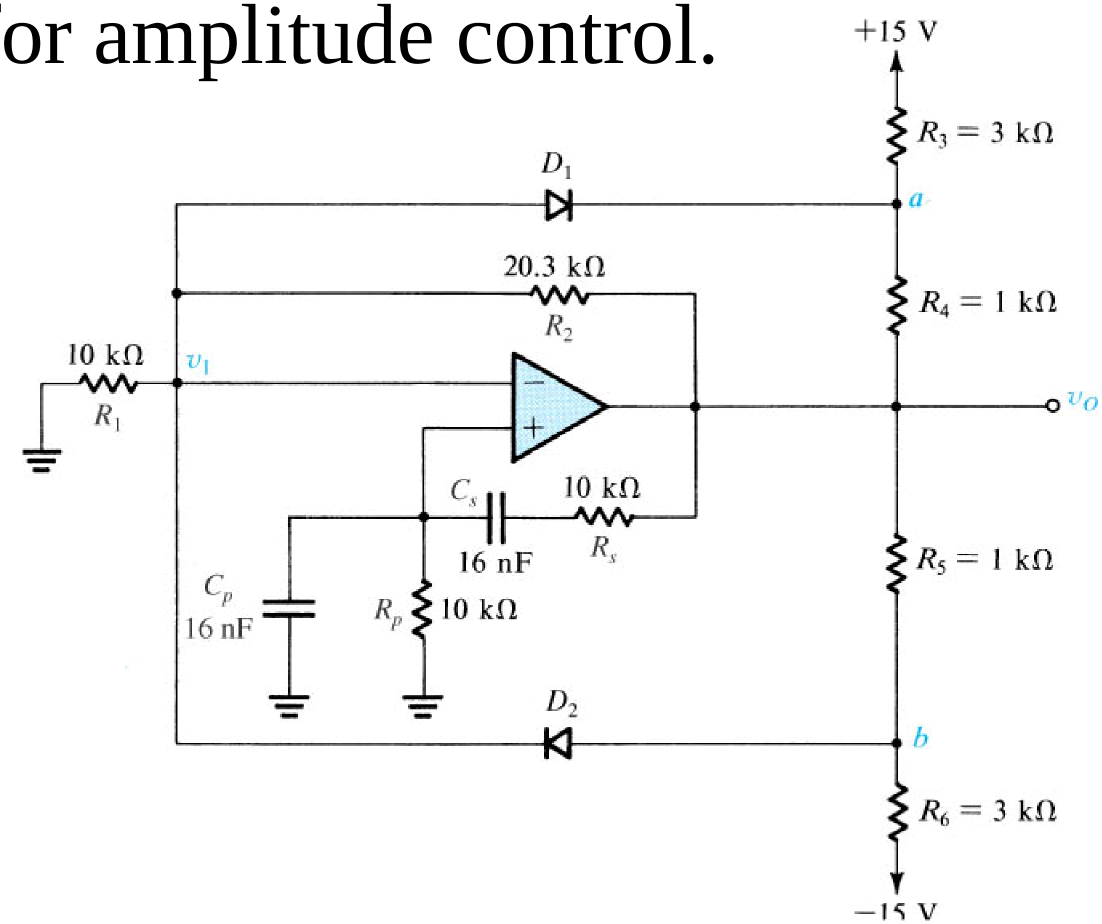
Wien-bridge oscillator



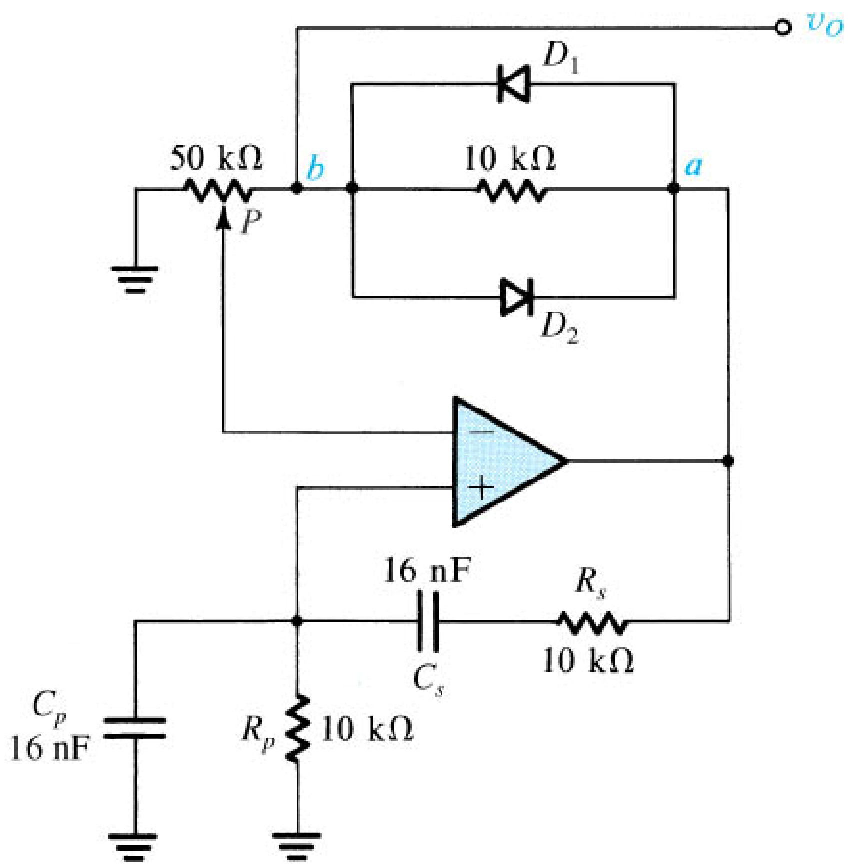
without amplitude stabilization.

Wien bridge w/ Amp. Stabil.

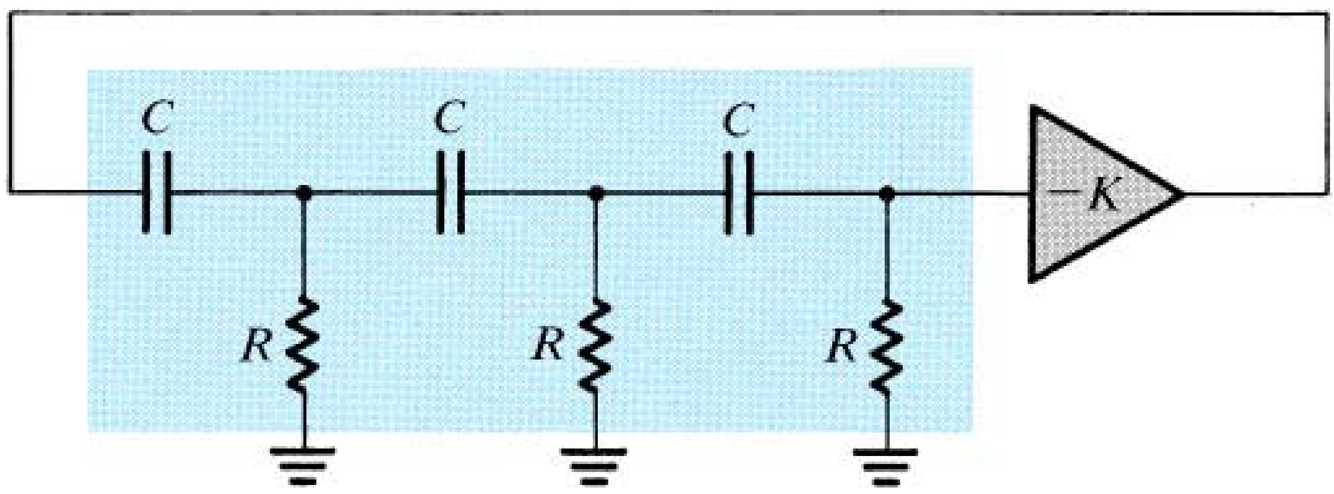
limiter used for amplitude control.



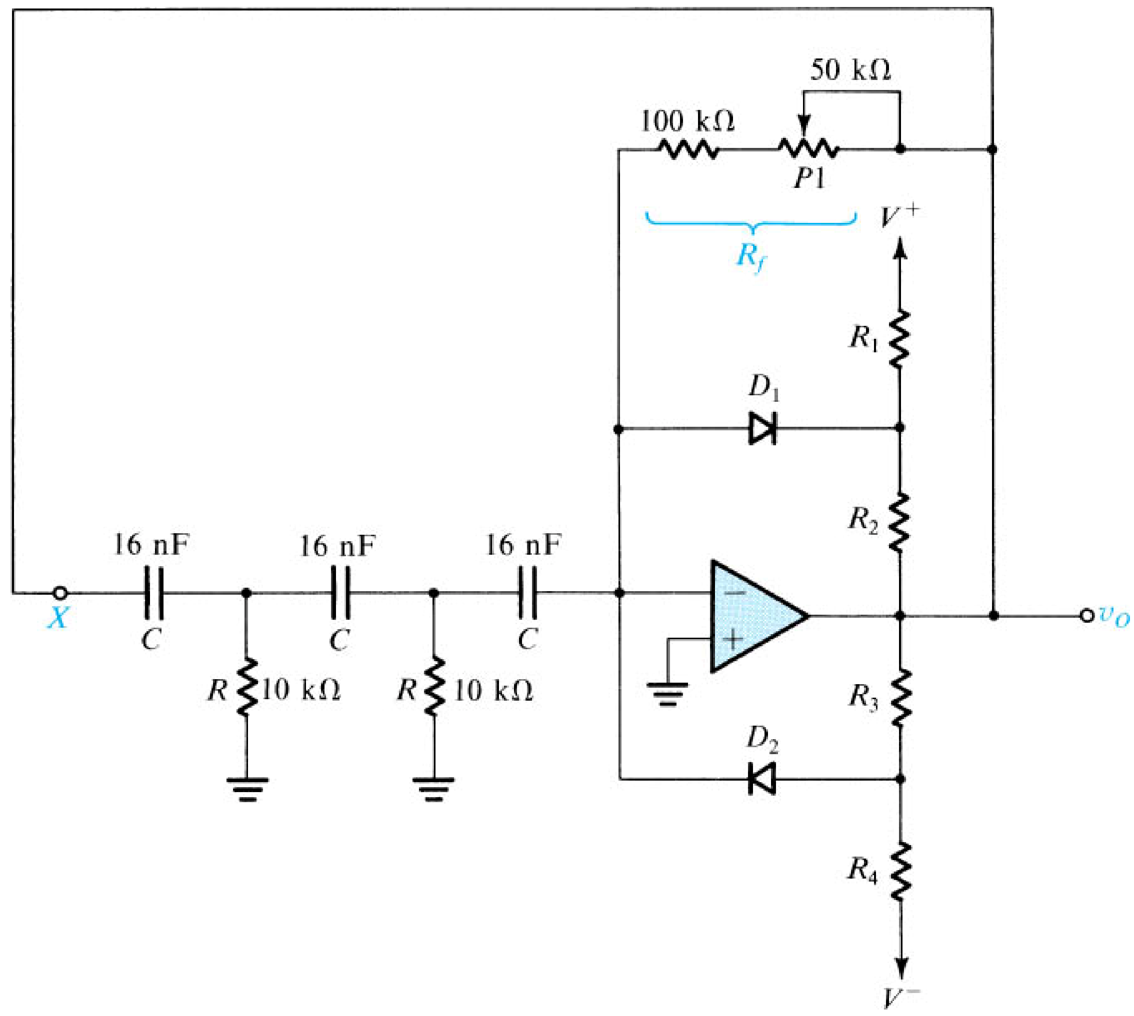
Alternate Wien bridge stabil.



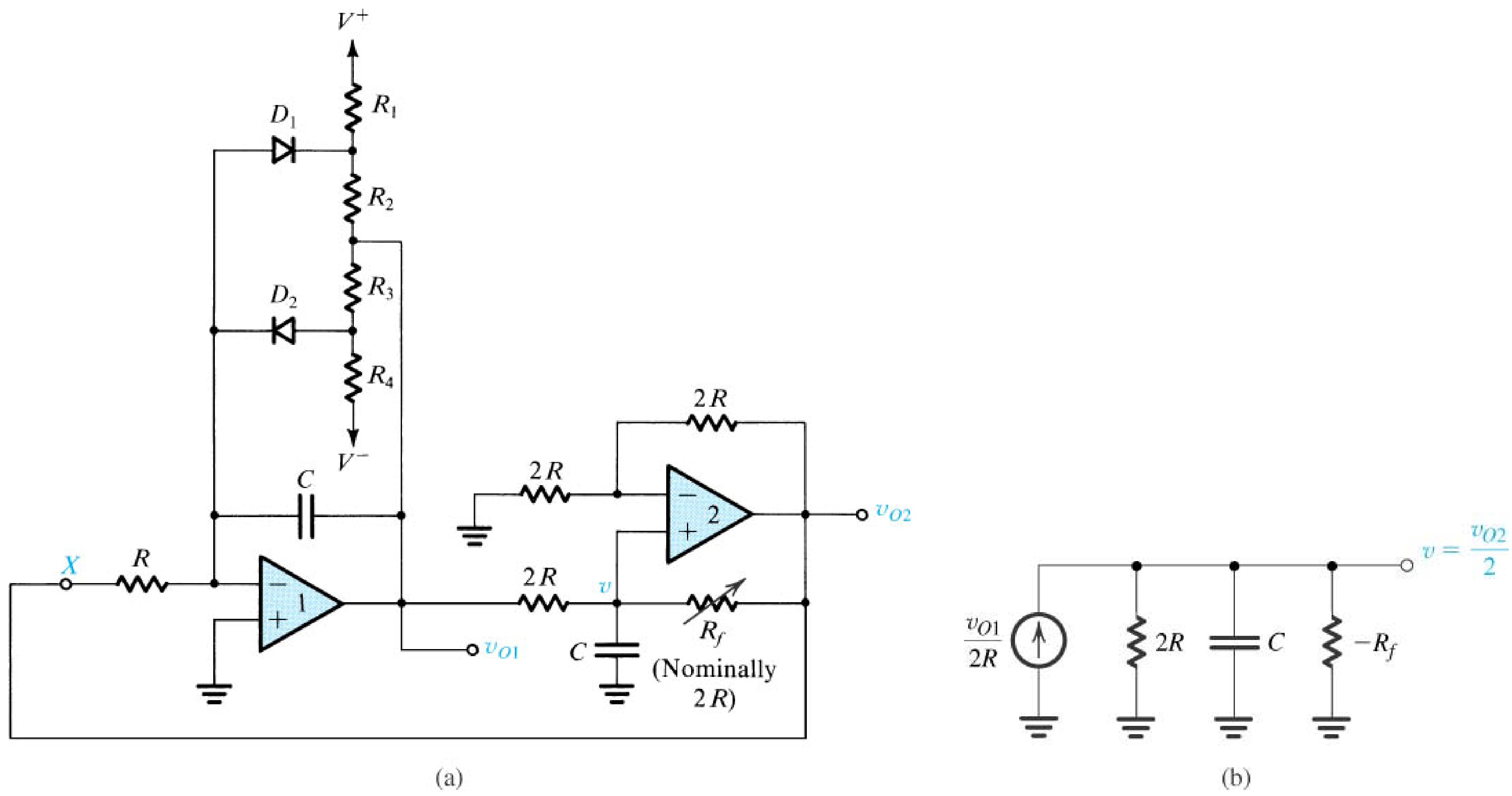
Phase Shift Oscillator



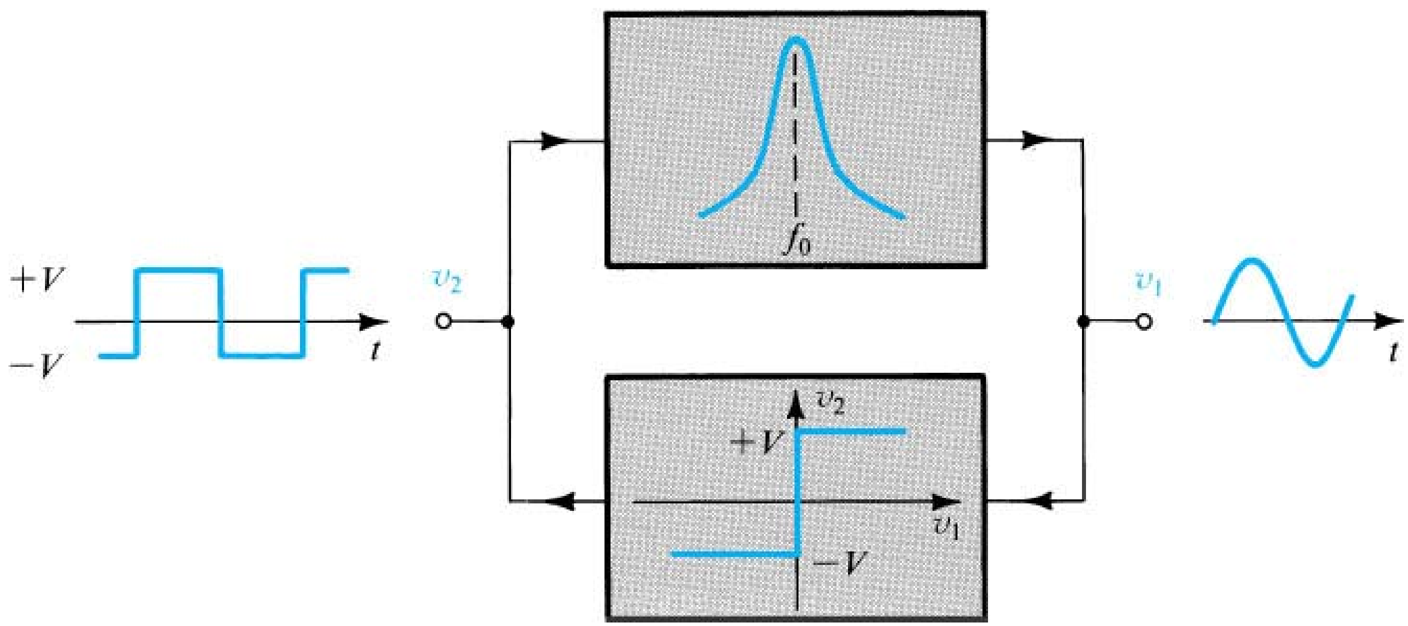
Phase Shift. Osc. W/ Stabil.



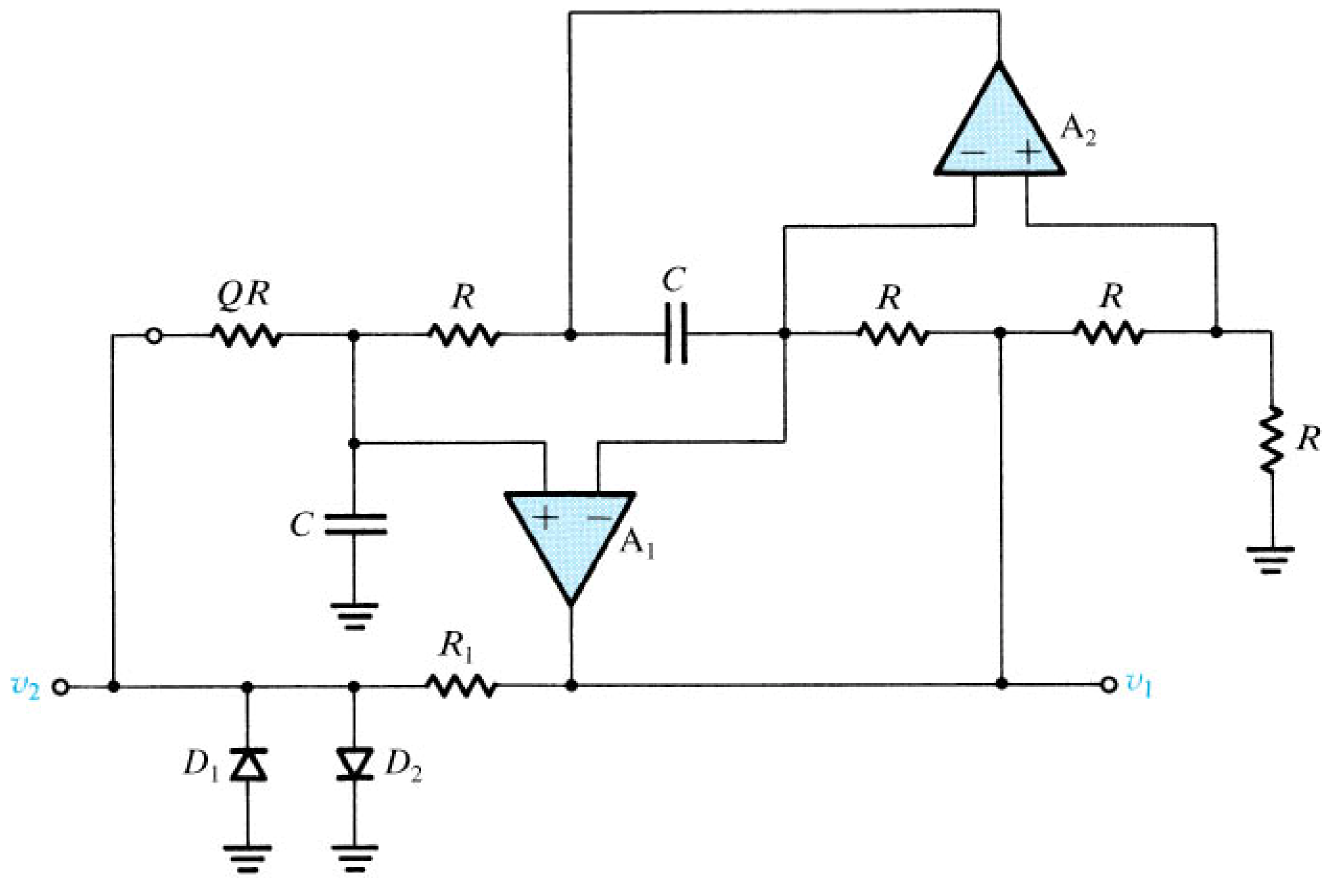
Quad Osc. Circuit



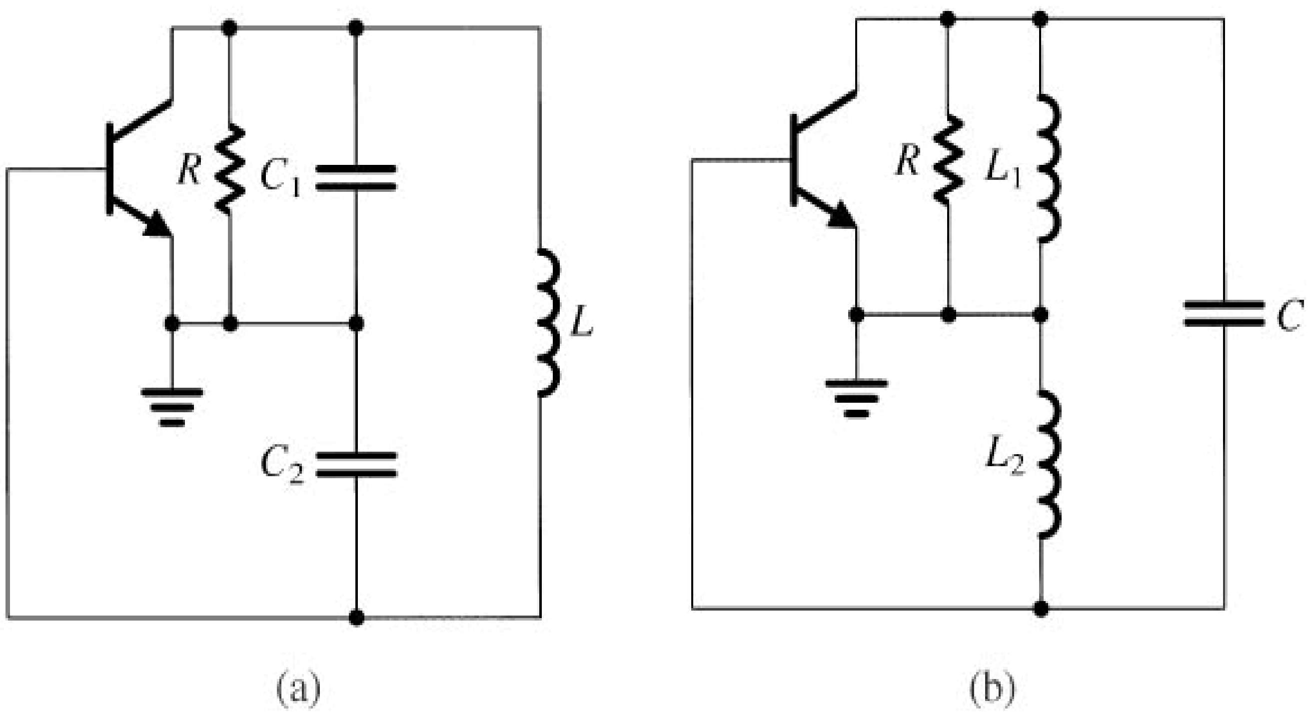
Active Tuned Osc.



OPAMP based Tuned Amp. Osc.



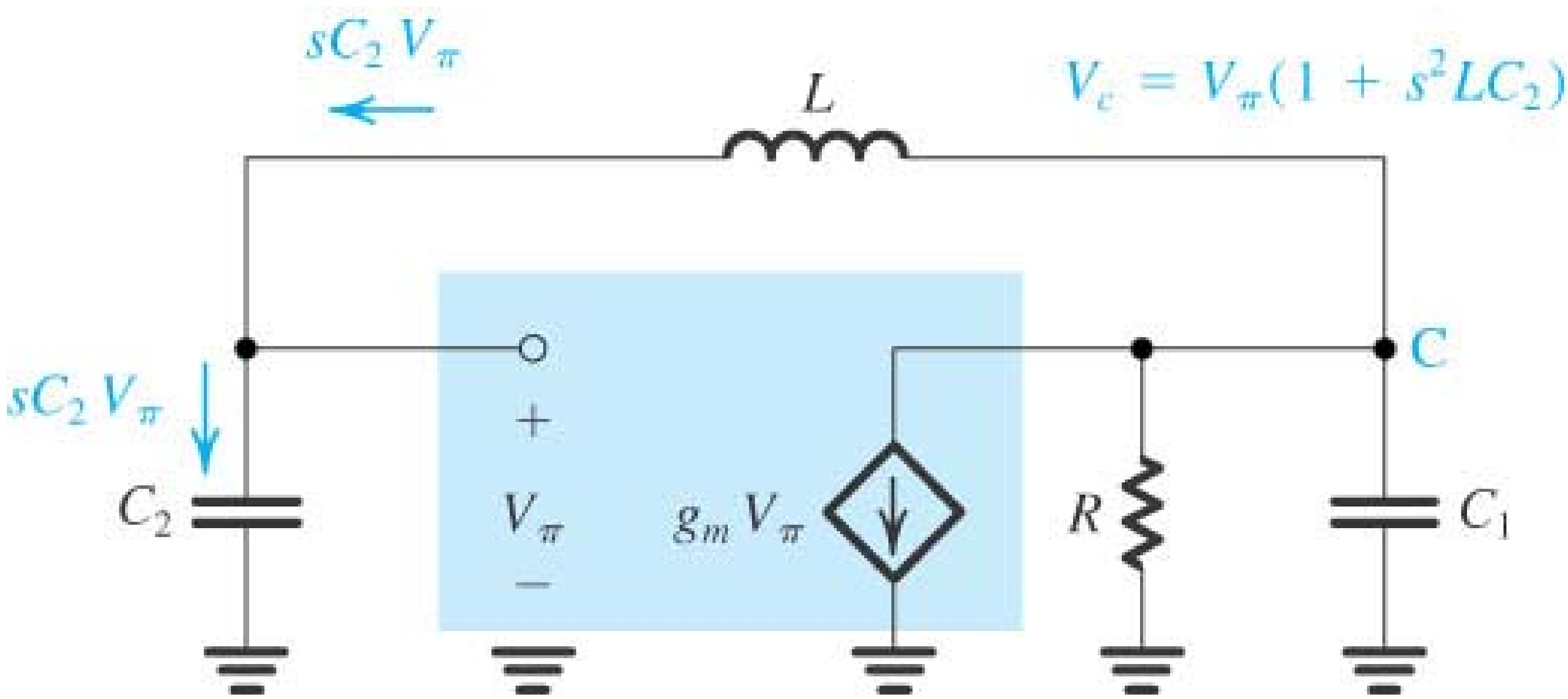
Colpitts and Hartley Oscillators



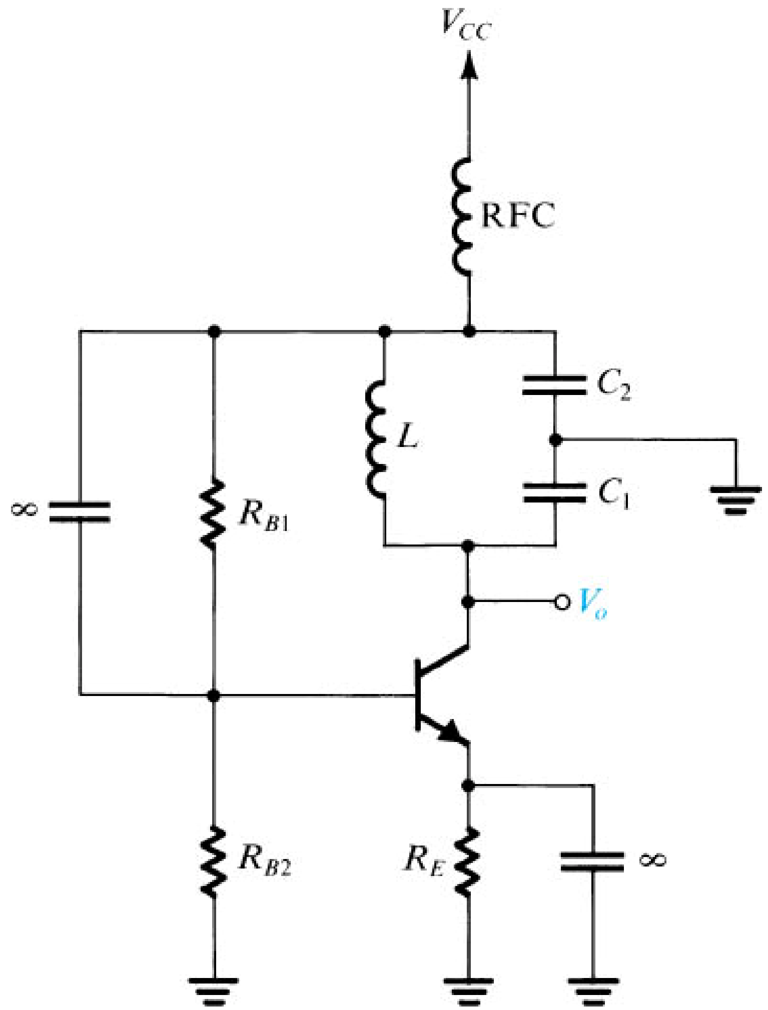
Equiv. Ckt

To simplify the analysis, negtlect C_m and r_p

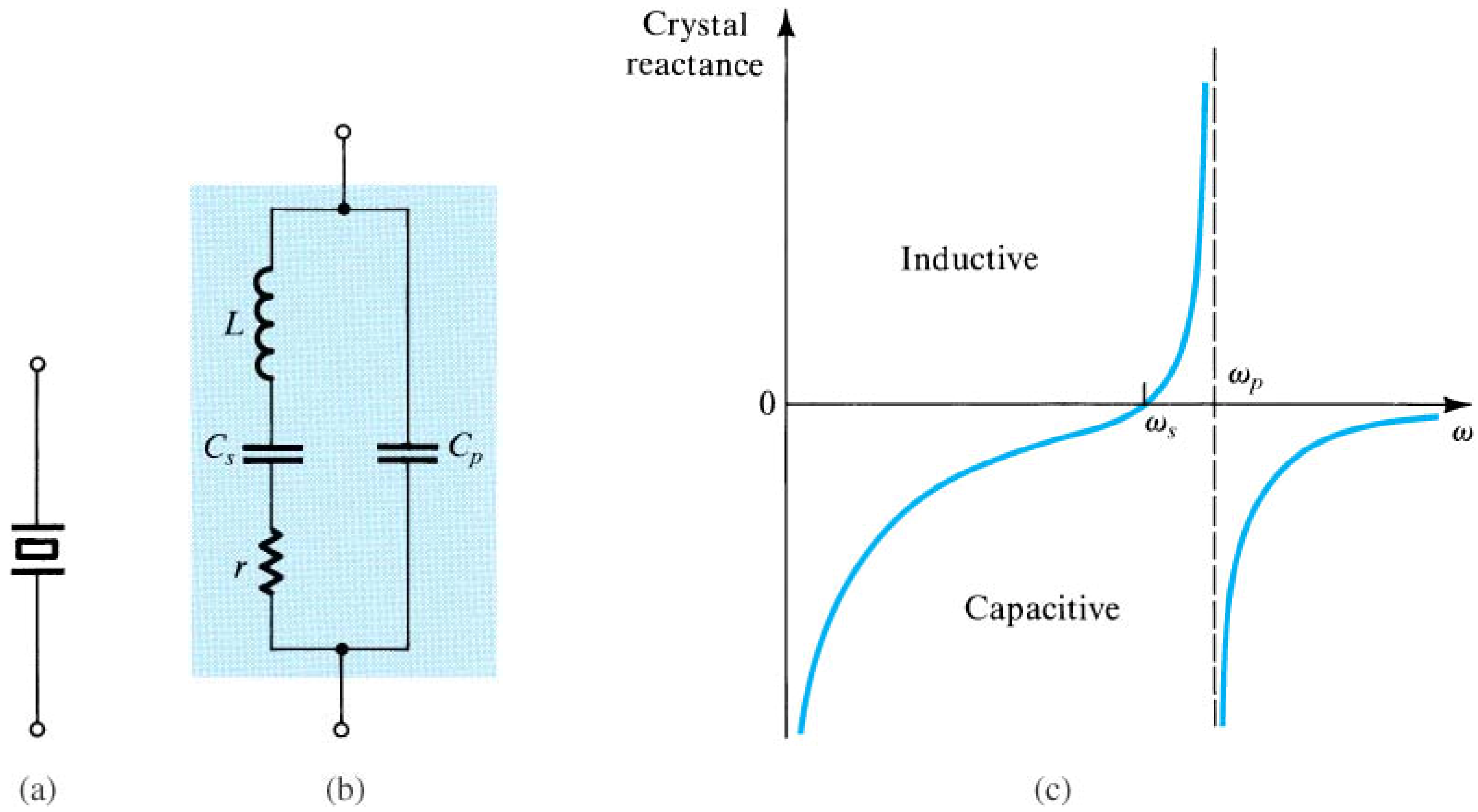
Consider C_p to be part of C_2, and include r_o in R.



Collpits Oscillator

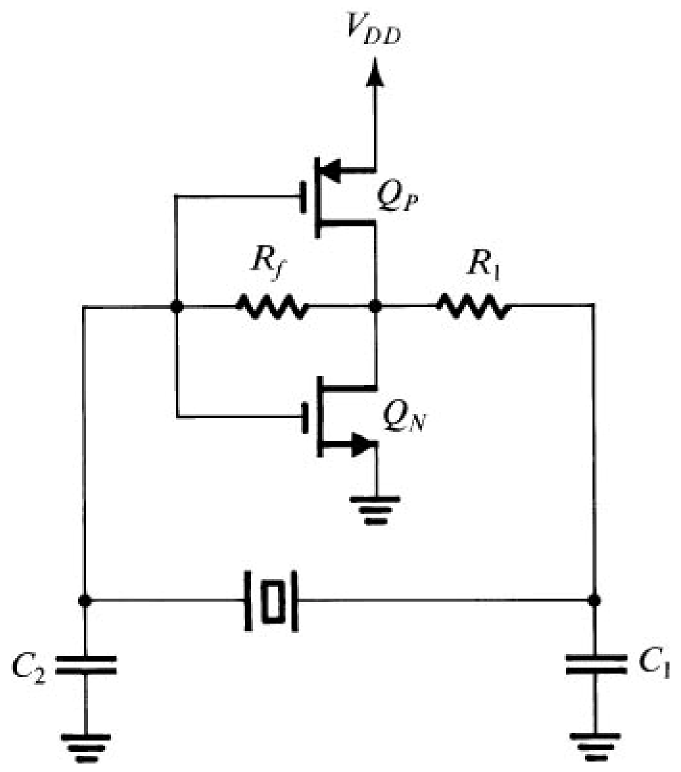


Piezoelectric Crystal



Pierce Oscillator

CMOS inverter as an amplifier.



Bistable Operation