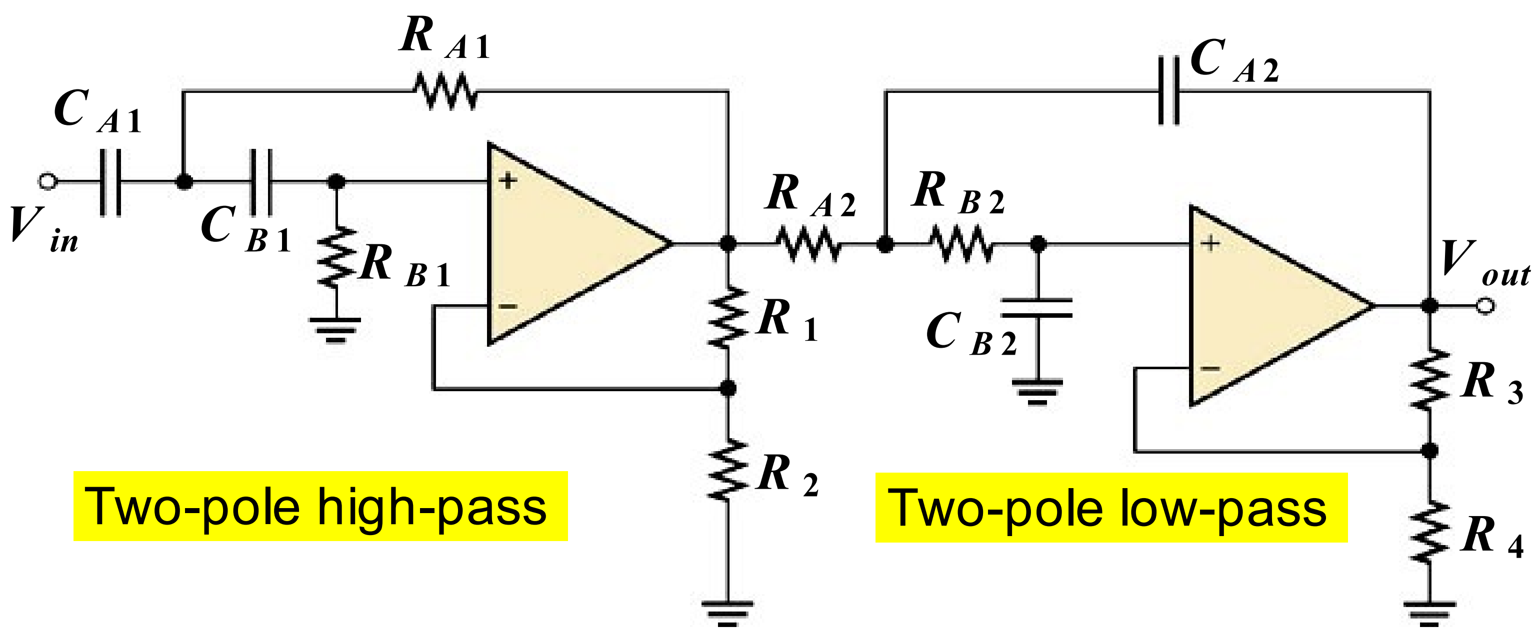
Unit-2
Lecture-7

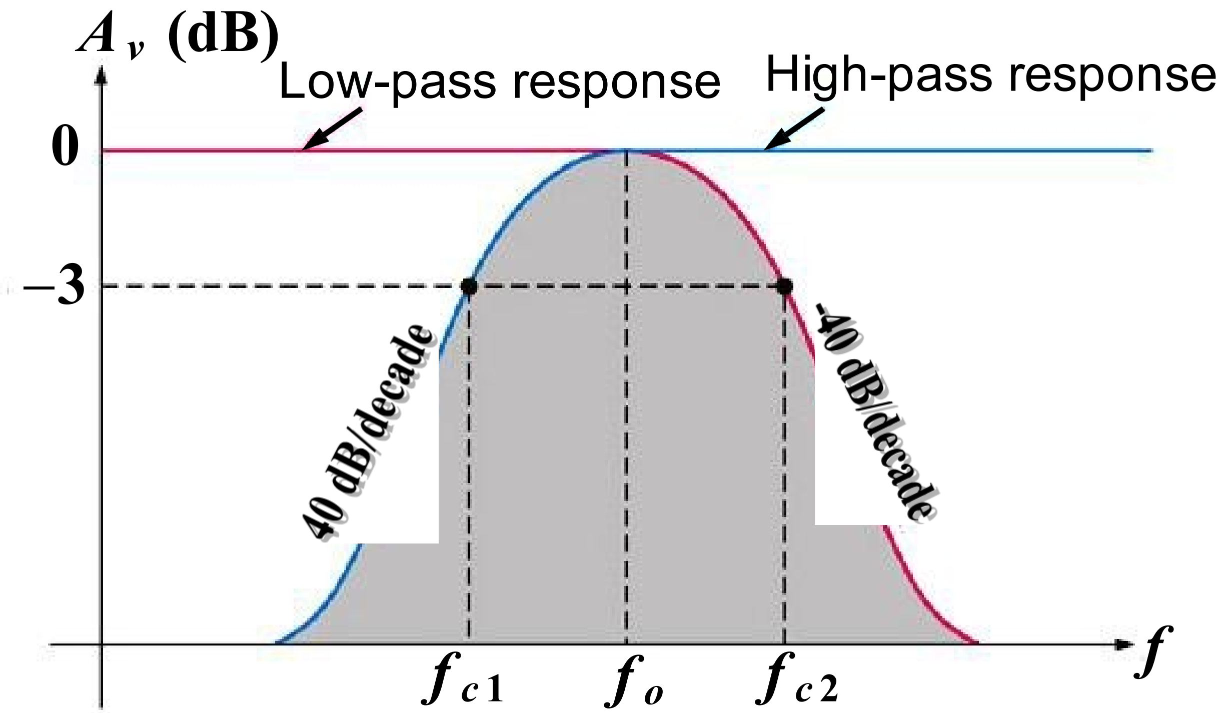
First and second order LP, HP, BP BS and All pass active filters, KHN,
Tow-Thomas and State Variable Biquad filters

ACTIVE BAND-PASS FILTERS

Cascaded Low-Pass and High-Pass Filters

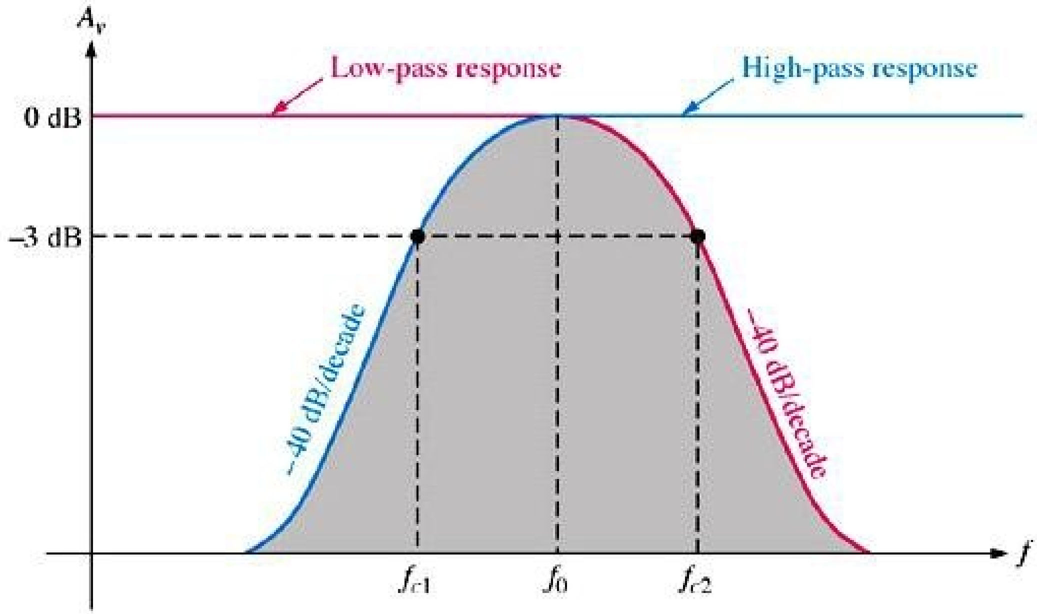


- Band-pass filter is formed by cascading a two-pole high-pass and two pole low-pass filter.
- Each of the filters shown is Sallen-Key Butterworth configuration, so that the roll-off rate are -40dB/decade.



➢The lower frequency f_{c1} of the passband is the critical frequency of the high-pass filter.

➢The upper frequency f_{c2} of the passband is the critical frequency of the low-pass filter.



- The following formulas express the three frequencies of the band-pass filter.

$$f_{c1} = \frac{1}{2\pi\sqrt{R_{A1}R_{B1}C_{A1}C_{B1}}}$$

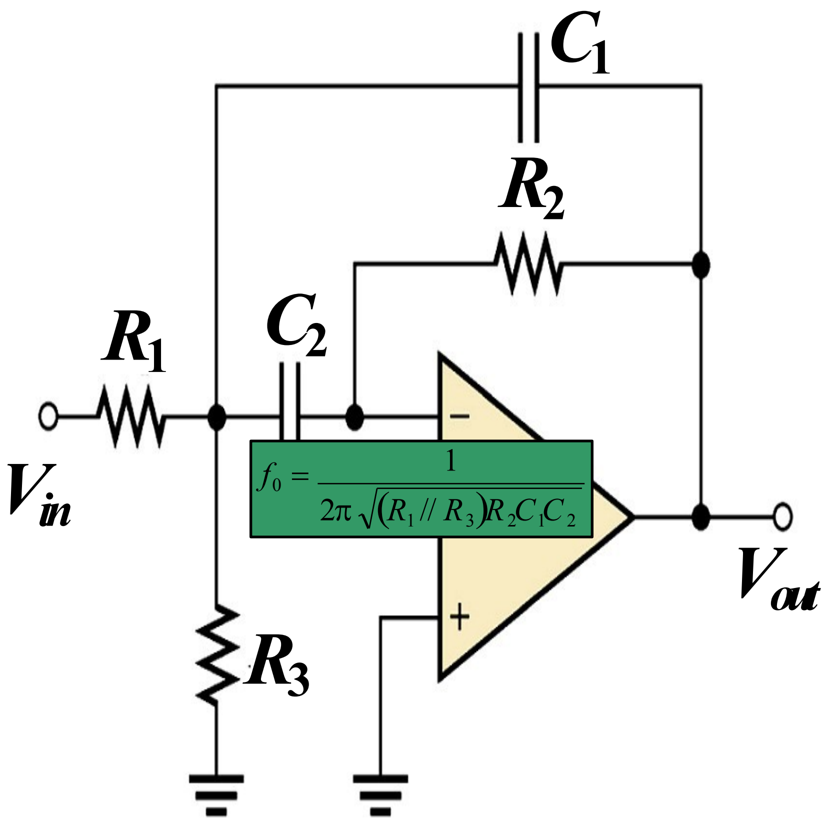
$$f_{c2} = \frac{1}{2\pi\sqrt{}}$$

$$f_0 = \sqrt{f_{c1}f_{c2}}$$

- If equal-value components are used in implementing each filter,

$$f_c = \frac{1}{2\pi RC}$$

Multiple-Feedback Band-Pass Filter



- The low-pass circuit consists of R_1 and C_1.
- The high-pass circuit consists of R_2 and C_2.
- The feedback paths are through C_1 and R_2.
- Center frequency;

- By making C1 = C2 =C, yields

$$f_0 = \frac{1}{2\pi C}\sqrt{\frac{R_1 + R_3}{R_1 R_2 R_3}}$$

- The resistor values can be found by using following formula

$$R_1 = \frac{Q}{2\pi f_o C A_o}$$

R_2 1

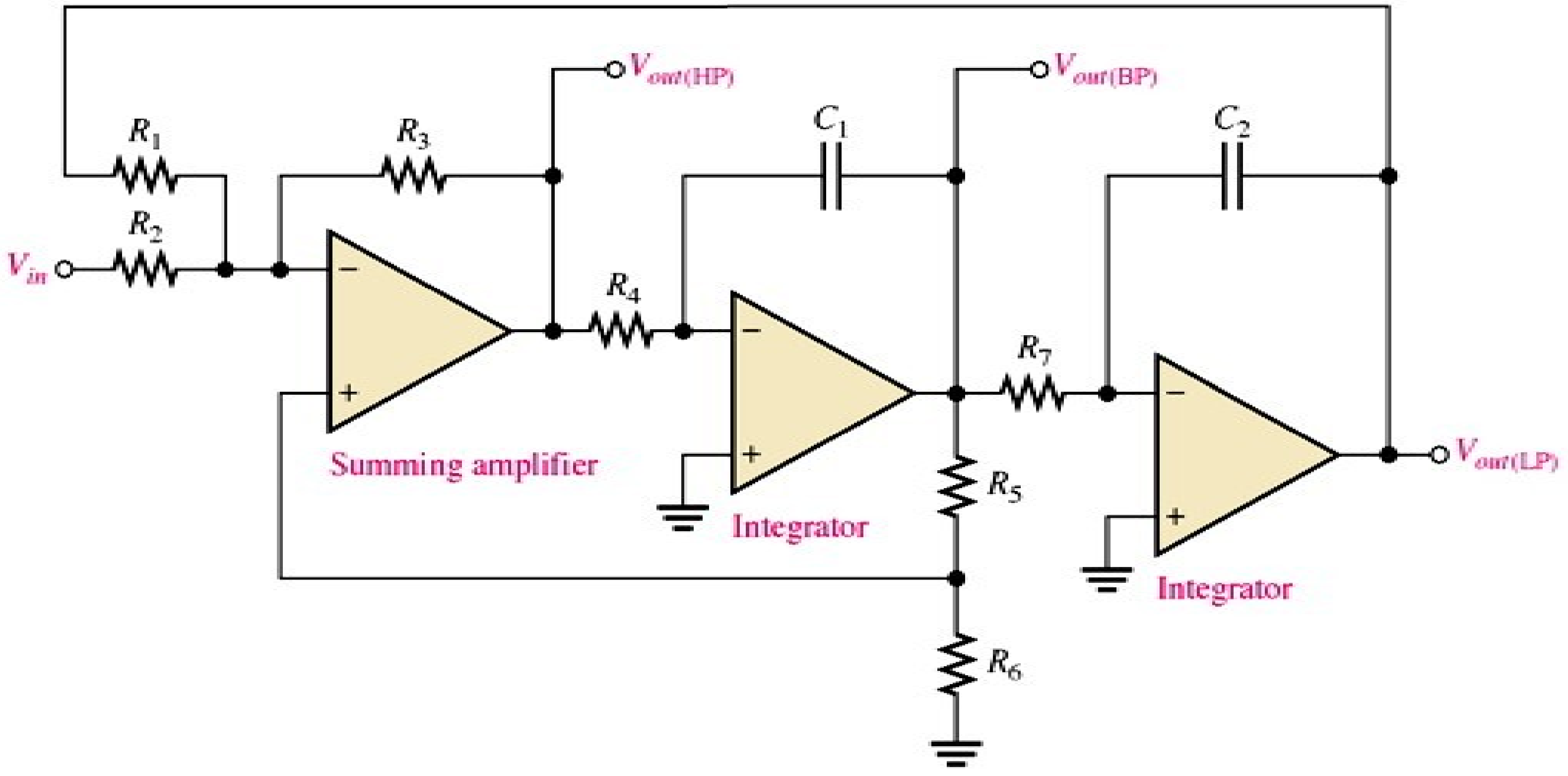
$$R_2 = \frac{Q}{\pi f_o C}$$

$$2\pi f_o C(2Q^2 - A_o)$$

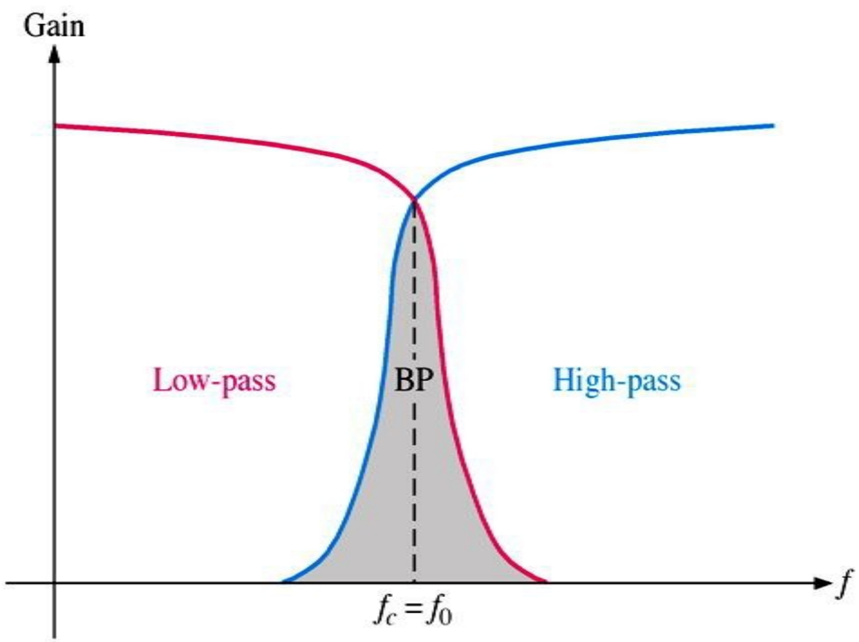
- The maximum gain, A_o occurs at the center frequency.

State-Variable Filter

- State-Variable BPF is widely used for band-pass applications.



- It consists of a summing amplifier and two integrators.
- It has outputs for low-pass, high-pass, and band-pass.
- The center frequency is set by the integrator RC circuits.
- The critical frequency of the integrators usually made equal
- R_5 and R_6 set the Q (bandwidth).



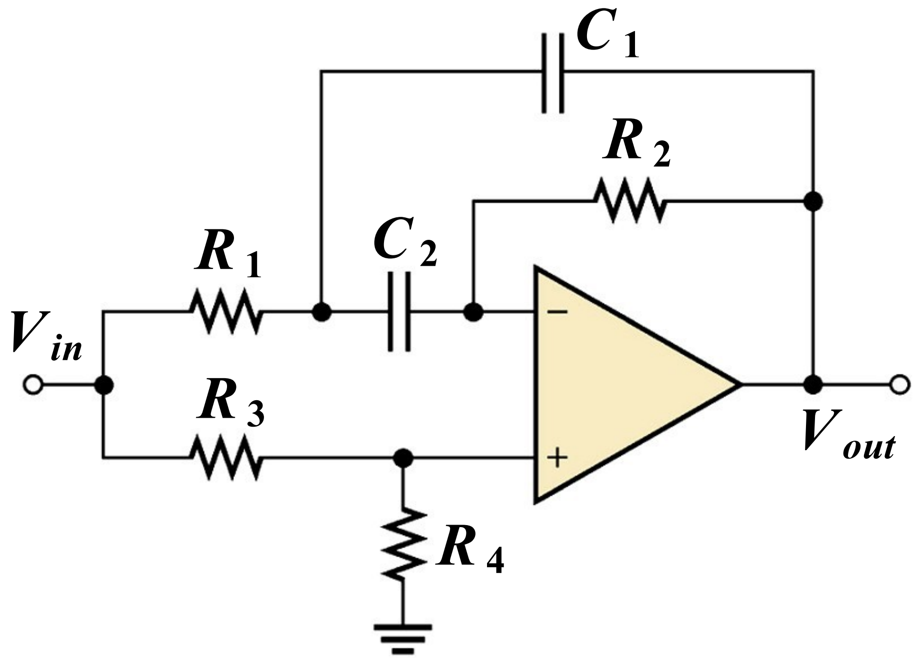
- The band-pass output peaks sharply the center frequency giving it a high Q.

- The Q is set by the feedback resistors R_5 and R_6 according to the following equations :

$$Q = \frac{1}{3}\left(\frac{R_5}{R_6} + 1\right)$$

ACTIVE BAND-STOP FILTERS

Multiple-Feedback Band-Stop Filter



- The configuration is similar to the band-pass version BUT R_3 has been moved and R_4 has been added.
- The BSF is opposite of BPF in that it blocks a specific band of frequencies

FILTER RESPONSE MEASUREMENT

- Measuring frequency response can be performed with typical bench-type equipment.
- It is a process of setting and measuring frequencies both outside and inside the known cutoff points in predetermined steps.
- Use the output measurements to plot a graph.
- More accurate measurements can be performed with sweep generators along with an oscilloscope, a spectrum analyzer, or a scalar analyzer.

- The Bessel response exhibits a linear phase characteristic, and filters with the Bessel response are better for filtering pulse waveforms.

- A filter pole consists of one RC circuit. Each pole doubles the roll-off rate.
  The Q of a filter indicates a band-pass filter’s selectivity. The higher the Q the narrower the bandwidth.

- The damping factor determines the filter response characteristic.