Filters

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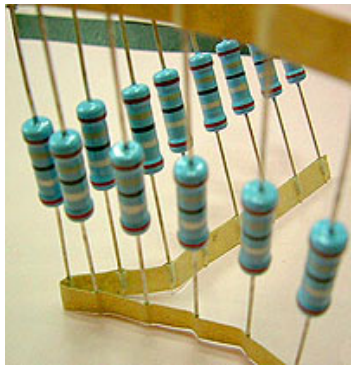
Filter Types

- **Analog Filters**
- **Digital Filters**

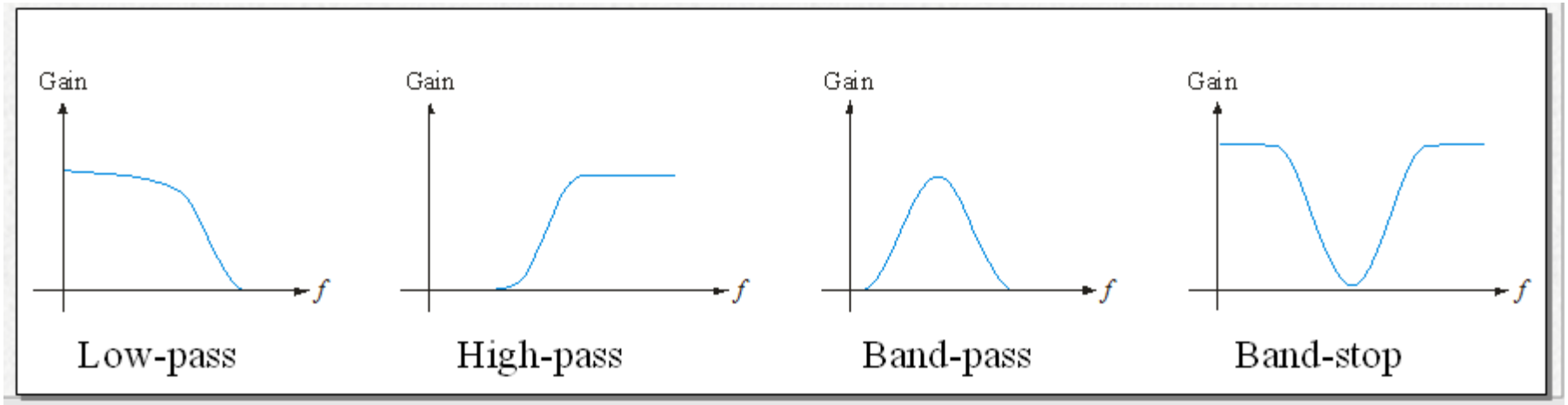


- **Passive Filters**: uses passive R L C circuits
- **Active Filters**: uses Op-amps or transistors combined with passive R L C circuits
  - Active devices provide voltage gain
  - Passive R L C circuits provide frequency selectivity

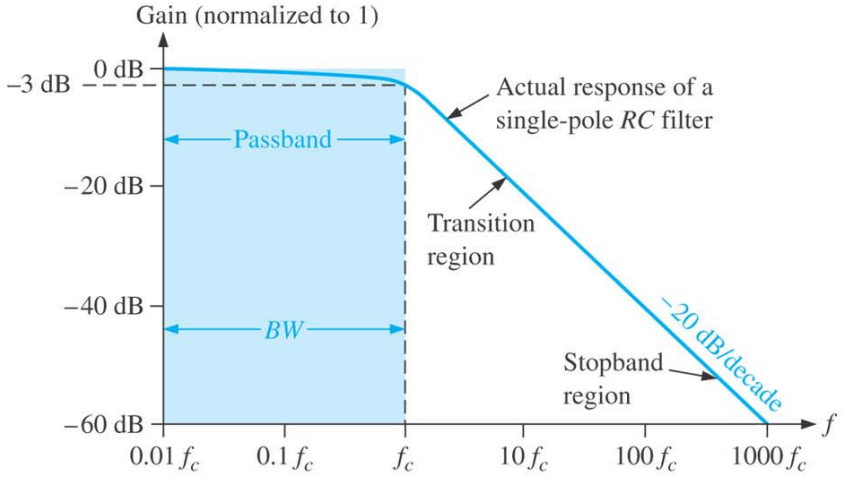
Note. Active Filters require power supplies for operation.

Basic Filter Response

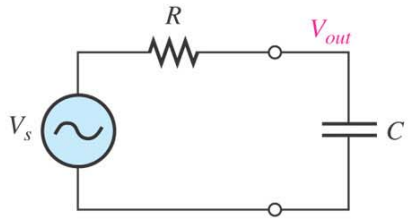
- **Filters** is a circuit that passes certain frequencies and attenuate or reject all other frequencies.
- **Passband** is the range of frequencies allowed through the filter.
- **The critical frequency,f_c**, also called *cuttoff frequency* define the end of passband.(a point where the response drops -3dB or 70.7% from the passband response)



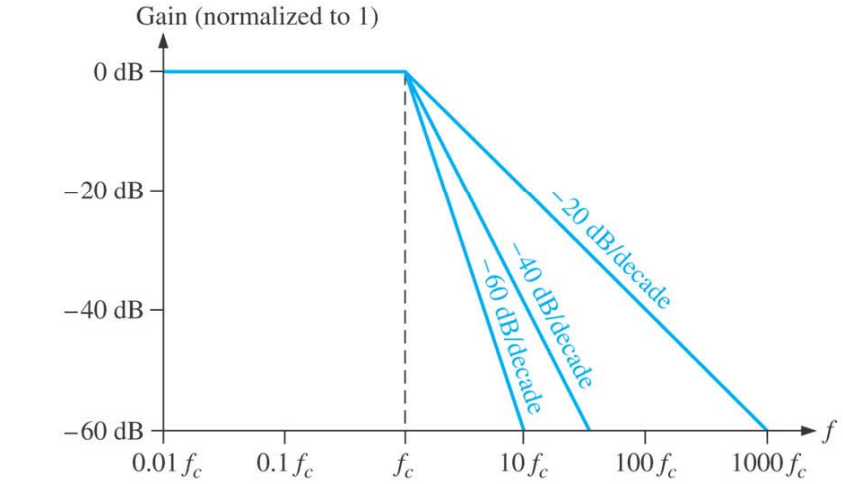
Low-pass filter response



(a) Comparison of an ideal low-pass filter response (blue area) with actual response



(b) Basic low-pass circuit

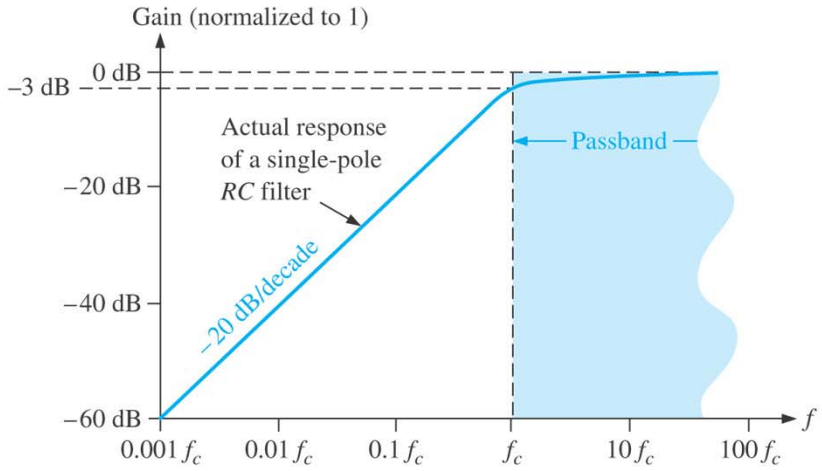


(c) Idealized low-pass filter responses

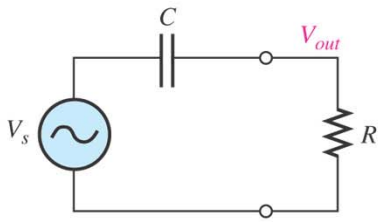
1. LP filter passes frequencies from dc to f_c.
2. Bandwidth(BW) = f_c
3. Poles: a circuit contained one R and C that contributes -20 dB/decade roll-off rate.

$$f_c = {}^{1}/_{2\pi RC}$$

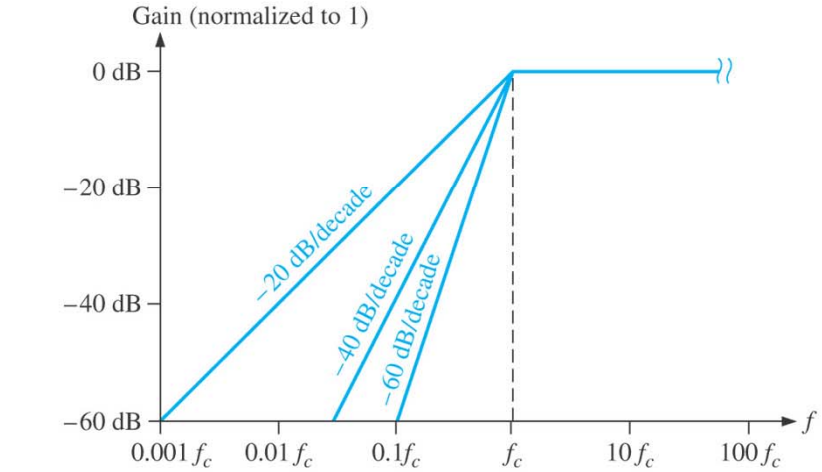
High-pass filter response



(a) Comparison of an ideal high-pass filter response (blue area) with actual response



(b) Basic high-pass circuit

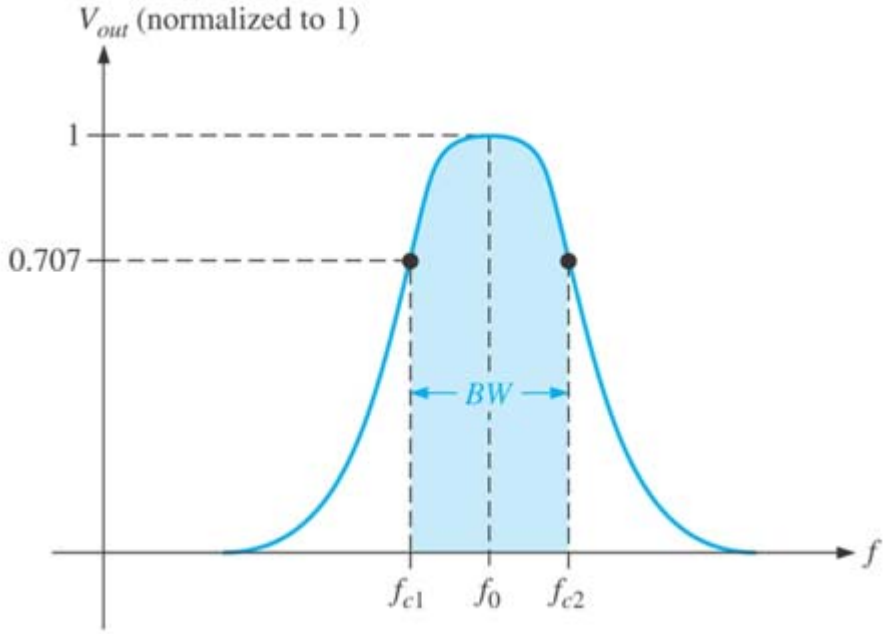


(c) Idealized high-pass filter responses

1. HP filter passes frequencies above f_c.
3. Poles: a circuit contained one R and C that contributes -20dB/decade roll-off rate.

$$f_c = {}^{1}/_{2\pi RC}$$

Band-pass filter response



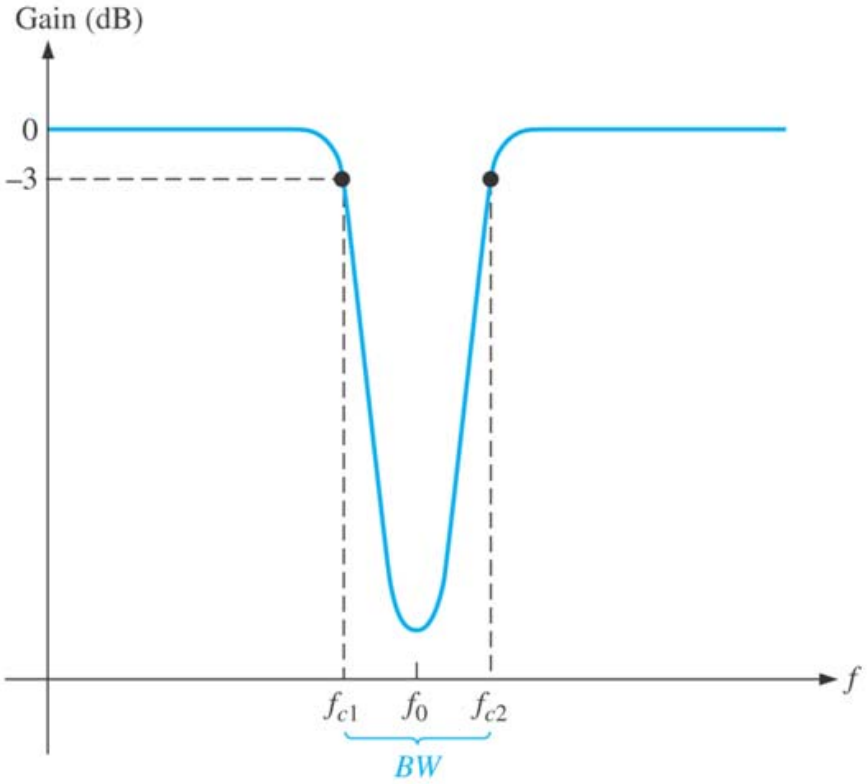
1. BP filter passes frequencies lying between f_{c1} and f_{c2}.
2. Bandwidth(BW) = f_{c2}-f_{c1}
3. The center frequency, f_0 is defined as;

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

4. The quality factor(Q) is the ratio of fo to BW.

$$Q = \frac{f_0}{BW}$$

Band-stop filter response



Also known as Notch, band-reject or band-elimination filter.

1. BS filter eliminates frequencies lying between f_{c1} and f_{c2}.
2. Bandwidth(BW) = f_{c2}-f_{c1}
3. The center frequency, f_0 is defined as;

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

4. The quality factor(Q) is the ratio of fo to BW.

$$Q = \frac{f_0}{BW}$$