Today, we will:

- Do some example problems – Filters
- Review the pdf module: **Digital Filters**

Example: Low-pass filter circuit

Given: The following components are available:

- two resistors, 10.0 kΩ and 87.0 kΩ
- a capacitance decade box

The input voltage contains a signal frequency of 50 Hz, and some unwanted noise at 1000 Hz. We want to amplify the signal, with $G_{\text{amplifier}} \approx 8.5$, and we decide to use a first-order low-pass filter with a cutoff frequency of 200 Hz to attenuate the noise.

(***a***) **To do**: Draw the filter circuit and calculate the required capacitance.

Solution:

(***b***) **To do**: Calculate the overall gain of both the signal and the noise, and calculate how well we have improved the signal-to-noise ratio (SNR). *Note*: ***SNR is the ratio of signal power to noise power.*** Since electrical power is proportional to voltage^2, we define SNR as $\boxed{\text{SNR} = \dfrac{\text{Power}_{\text{signal}}}{\text{Power}_{\text{noise}}} = \left(\dfrac{|V_{\text{signal}}|}{|V_{\text{noise}}|}\right)^2}$, or in terms of decibels, $\boxed{\text{SNR}_{\text{dB}} = 20\log_{10}\left(\dfrac{|V_{\text{signal}}|}{|V_{\text{noise}}|}\right)}$.

Solution:

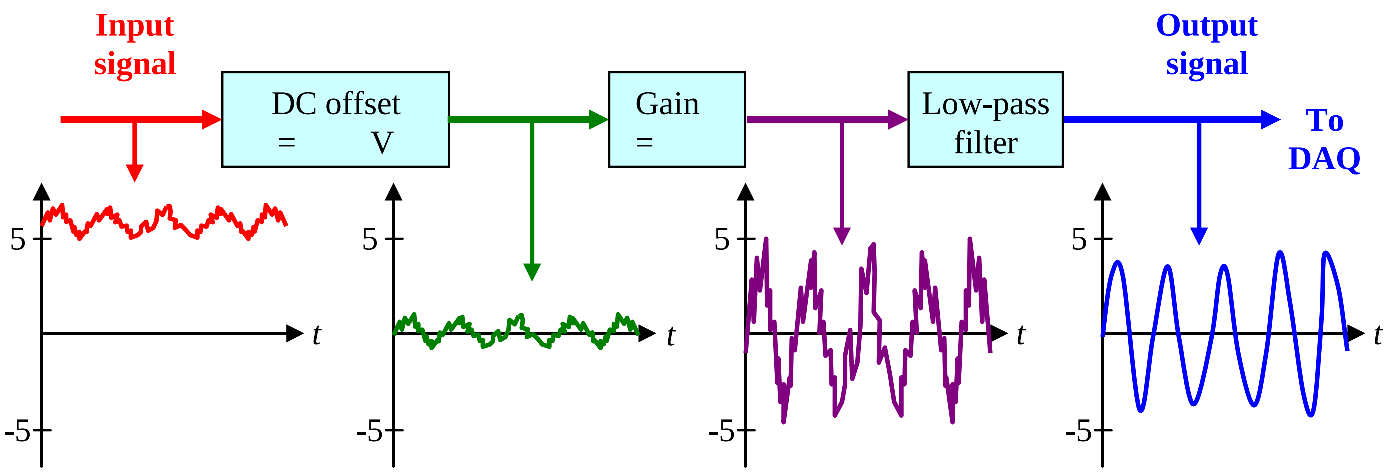
Example: Digital data acquisition and Filters

Given: A voltage signal has a frequency around 100 Hz, and ranges from 5.0 to 6.0 volts. There is also some unwanted AC noise at a frequency around 5000 Hz, with an amplitude of ±0.005 V. The digital data acquisition system is 12-bit, and has a range from -5 to 5 volts.

(*a*) To do: Calculate an appropriate DC offset and gain in order to utilize the full range of the A/D system.

Solution: DC offset = V, Gain = .

Schematic diagram of the circuitry:



(*b*) To do: Design a first-order filter with these requirements:

- Use resistors and capacitors only
- Don't attenuate the 100 Hz signal by more than 25% (after the gain).
- Attenuate the 5000 Hz noise to lower than the quantizing error of the A/D system (in other words, remove it completely, since its amplitude will be reduced to the noise level of the A/D converter).

Solution: