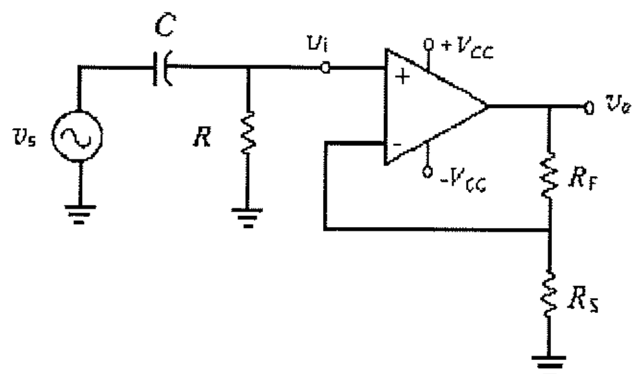
Op-Amp Homework Problems

Note: These op-amp review problems maybe configured slightly differently from the schematics we discussed in class; however. the methodology and solutions are the same.

1. Calculate pass band gain and the cut-off frequency for a 1st order high pass active filters.

Identify type of filter and calculate the cut-off frequency and pass band gain for

$R = 4.7\ K\Omega$
$C = 0.01\ \mu f$
$R_F = 91\ K\Omega$
$R_S = 5.1\ K\Omega$

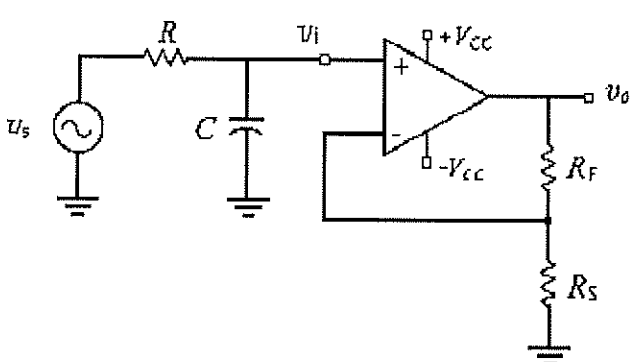


Answers:
High Pass Filter
Cut-Off Freq = 3.38 KHz
Pass Band Gain = 22.5 dB

2. Calculate pass band gain and the cut-off frequency for a 1st order low pass active filters.

Identify type of filter and calculate the cut-off frequency and pass band gain for

$R = 5.1 K\Omega$
$C = 0.01\mu f$
$R_F = 33\ K\Omega$
$R_S = 4.7\ K\Omega$



Answers:
Low Pass Filter
Cut-Off Freq = 3.12 KHz
Pass Band Gain = 18 dB

Op-Amp Homework Solutions

Problems 1 & 2 Active Op-Amp Filters

The input is connected to V+ indicating a non-inverter configuration.
The negative feedback loop from Vout to V- has a gain of (1 + Rf/Rs) for non-inverting input.
The input represents a voltage divider Vs, Xc, R.

Cut-Off Frequency for both Low Pass and High Pass Filters: $f_o = 1 / (2\pi RC)$
Pass Band Gain (in dB) = 20log(1 + Rf/Rs)

1. Vi is the voltage across the resistor R, so

   Vi = Vs (R / (R + Xc)) where Xc = 1/jwC

   Vi = Vs (R / (R + 1/jwC)) dividing by R yields

   Vi = Vs (1 / (1 + 1/jwRC)) and

   Vout = (1 + Rf/Rs) * Vi = (1 + Rf/Rs) * Vs (1 / (1 + 1/jwRC)

   Vout/Vs = (1 + Rf/Rs) * (1 / (1 + 1/jwRC))

   Let A = (1 + Rf/Rs) and T = RC or Vout/Vs = A * (1 / (1 + 1/jwT))
   which is the same as we deduced in class for a High-Pass Filter,
   although we multiplied by jwT and wrote it as: A * (jwT / (1 + jwT)).

   Why high pass? If w=0 then Vout/Vs = 0.
   If w becomes very large, then Vout/Vs approaches A.
   Hence, the circuit blocks low frequencies and passes high frequencies.

2. Vi is the voltage across the capacitor C, so

   Vi = Vs (Xc / (R + Xc)) where Xc = 1/jwC

   Vi = Vs (1/jwC / (R + 1/jwC)) multiplying by jwC yields

   Vi = Vs (1 / (jwRC + 1)) = Vs (1 / (1 + jwRC)) and

   Vout = (1 + Rf/Rs) * Vs (1 / (1 + jwRC))

   Vout/Vs = (1 + Rf/Rs) / (1 + jwRC))

   Let A = (1 + Rf/Rs) and T = RC or Vout/Vs = A / (1 + jwT)
   which is the same as we deduced in class for a Low-Pass Filter.

   Why low pass? If w=0 then Vout/Vs = A / (1 + 0) = A.
   If w becomes very large, then Vout/Vs becomes very small.
   Hence, the circuit passes low frequencies and blocks high frequencies.