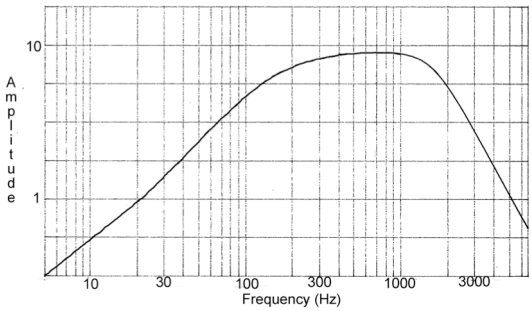
Phys 120 - Open book final exam - 9 June 2016 _____ _____

Name **Student No.**

The goal of the "final" exercise is to build a band-pass amplifier. The specifications are:

1. A very high, i.e., FET-like, input impedance.
2. A very low, i.e., ~ few Ohms, output impedance
3. A pass-band of ~ 150 to ~ 1500 Hz
4. A composite gain of +5 to +10 in the pass-band
   - Gain $\propto f$ for $f << 150$ Hz
   - Gain $\propto 1/f^2$ for $f >> 1500$ Hz

See Bode plot, i.e., $log|V_{out}(f)/V_{in}(f)|$ versus $log(f)$, at the right.



Construct the band-pass amplifier in five stages, selecting from the following parts:

LF411 FET Op-Amp
2N5485 n-channel JFET
0.01 H inductor
0.001 μF, 0.01 μF, 0.1 μF, and 1.0 μF capacitors
1.0 kΩ, 4.7 kΩ, 9.1 kΩ, 10 kΩ, 11 kΩ, 91 kΩ, 100 kΩ, and 110 kΩ resistors

(A) Use an FET follower with a current source as a load for the input buffer. In particular, (re)build the *exact* circuit from exercise 7.5 (figure 7.9 in laboratory 7).

(*1*) What is the gain at 50 Hz?, 500 Hz, 5,000 Hz? Use a 1.0 $V_{peak\text{-}to\text{-}peak}$ sine wave.

(*2*) What is the offset voltage?

(B) Build a high-pass filter (laboratory 2) with a capacitor and a resistor with $f_{3dB} \sim 150$ Hz. To minimize loading on the FET follower, pick $R \geq 100$ kΩ.

(*3*) What is the desired time constant, τ?

(*4*) What R and C combination did you choose?

(*5*) What is your measured f_{3dB} (high pass)?

Connect stages (A) and (B).

(C) Use an FET Op-Amp to build an amplifier (laboratory 4) that has a gain $G \approx +10$.

(*6*) What circuit configuration, i.e., inverting vs. non-inverting, should you use?

(*7*) What resistance values did you choose for the circuit?

Connect stages (A), (B), and (C).

(D) Build a low pass / resonant circuit that will complete the band-pass (laboratory 2). Use an inductor with $L \approx 0.01$ H and a capacitor with $C \approx 1.0$ μF.

(*7*) How should these two elements be configured?

(*8*) What is the calculated transfer function for this circuit element, i.e., $V_{out}(f)/V_{in}(f)$ (ignore internal resistance in the inductor)?

Connect stages (A), (B), (C), and (D).

(*9*) What is your measured f_{3dB} (low pass) for this circuit, i.e., the high frequency cut-off?

(E) Use an FET Op-Amp to build a unity-gain follower (laboratory 4) that drives a 10 kΩ load.

Connect stages (A), (B), (C), (D), and (E).

(*10*) Measure the frequency dependence of your circuit at ~ 20 logarithmic steps in frequency (10 Hz to 10 kHz) and form a Bode plot on 3x3 cycle log-log paper.