ECE 3050 Analog Electronics Quiz 13

April 15, 2009

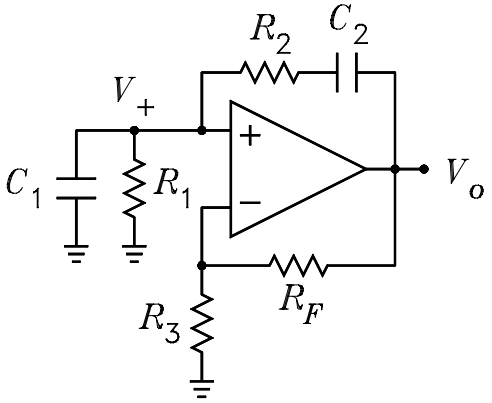
Professor Leach Name_____

Instructions. No calculators are allowed on this quiz. Print your name in the space above. **Honor Code:** *I have neither given nor received help on this quiz.* Initials _____

1 of 2. The figure shows a Wien Bridge oscillator that puts out a sine wave signal with no input signal.

(a) In words, how would you go about solving for the frequency at which this circuit would oscillate?
Answer: Break the loop between V_o and C_2, solve for the frequency at which the phase of the loop-gain transfer function is zero degrees, choose R_3 and R_F so that the loop gain is unity.

(b) One of the resistors in the circuit is to be varied electronically to maintain a constant amplitude sine wave at the op-amp output. If the value of the resistor increases as the amplitude of the output sine wave increases, which resistor would you vary? Explain your choice.
If $v_O(t)$ is increasing in amplitude, the gain of the op amp must be decreased to stabalize the amplitude. If the resistor increases in value, it should be where R_3 is in the circuit.



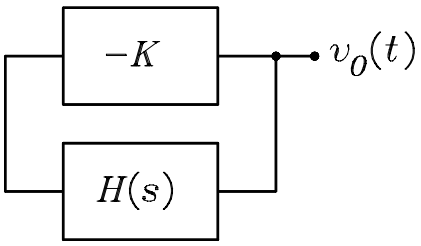
2 of 2. The block diagram of an oscillator which uses an inverting amplifier with a gain $-K$ is shown. The feedback network has the transfer function

$$H(s) = \frac{1}{(1+s/\omega_0)^3}$$

(a) Solve for the frequency at which the phase of the loop-gain transfer function $-KH(s)$ is $0\,^\circ$ (or any multiple of $360\,^\circ$).
Answer: The phase of $H(j\omega)$ must be $-180\,^\circ$. This occurs when

$$\tan^{-1}\left(\frac{\omega}{\omega_0}\right) = 60\,^\circ \Longrightarrow \omega = \omega_0 \tan(60\,^\circ) = \omega_0\sqrt{3}$$

(b) If the circuit is to oscillate at the frequency found in part (a), what must be the value of K?



At the oscillation frequency, $K\left|H(j\omega/\omega_0)\right| = K\left|1+j\sqrt{3}\right|^{-3} = 1$ or $K = \left|1+j\sqrt{3}\right|^3 = 8$.