

Name: _____
Section: KEY

EE334 Homework PS8

Problems from Supplement (Beige Book):

- 3.1

Additional Problems (Instructor Option):

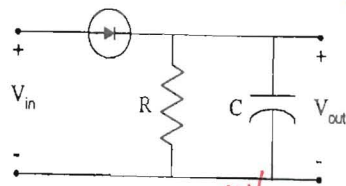
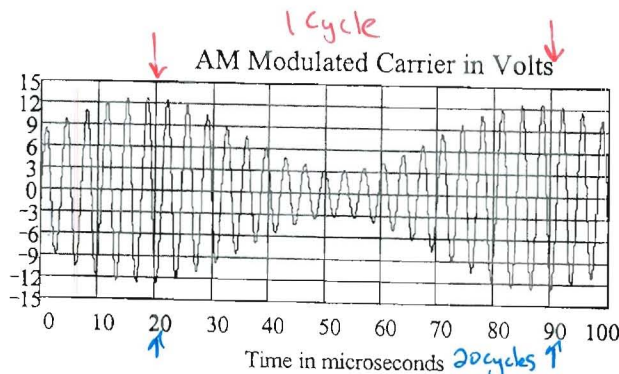
- Any as assigned by instructor
- 3.5

EE334 Homework PS8

Problem 3.1

The waveform shown below is applied to the input of the peak detector circuit. Assume an ideal diode. For parts a and b assume the proper choice has been made for the RC time constant

- Determine the maximum value of the detector audio output voltage.
- Calculate the DC (average) voltage at the detector output (Assume the peak detector follows the envelope ideally).
- Determine an appropriate value for the capacitor if $R = 5 \text{ K}\Omega$.
- Add a component(s) to the detector circuit below which will remove the average value found in part b. Indicate where the new output, with zero DC, is located.
- If the output is applied to a speaker, after the DC is removed (DC is not good for speakers), what will be audible?



$$(2.9) \quad V_{AM}(t) = 8 \cos(\underbrace{2\pi \cdot 285.7 \cdot 10^3 t}_{\omega_c}) + \frac{5}{2} \left[\cos(\underbrace{2\pi \cdot 300 \cdot 10^3 t}_{\omega_c + \omega_m}) + \cos(\underbrace{2\pi \cdot 271.4 \cdot 10^3 t}_{\omega_c - \omega_m}) \right]$$

$$(2.6) \quad V_c = \frac{V_{max} + V_{min}}{2} = \frac{13 + 3}{2} = \boxed{8V}$$

$$(2.7) \quad m = \frac{V_{max} - V_{min}}{V_{max} + V_{min}} = \frac{13 - 3}{13 + 3} = \boxed{\frac{5}{8} \text{ or } 0.625}$$

$$f_c = \frac{20 \text{ cycles}}{70 \mu s} \leftarrow (\text{From } 20 \rightarrow 90) = \boxed{285.7 \text{ KHz}}$$

$$f_m = \frac{1 \text{ cycle}}{70 \mu s} = \boxed{14.3 \text{ KHz}} \leftarrow \text{Pure Tone}$$

Next

Problem 3.1 cont.

a) Max. Value at V_{out}

$13V$

b) DC Value = V_c

$8V$

c) Appropriate Time Constant

(Pg. 24) $\tau_c = RC = \sqrt{T_c T_{m,max}}$

$C = \frac{\sqrt{T_c T_{m,max}}}{R} = 3.13 nF$

- $T_c = \frac{1}{f_c} = 3.5 \mu s$
- $T_{m,max} = 69.9 \mu s$
- $R = 5 k\Omega$

Note - on our AM Radios

ensures greater than T_{IF} → $\left\{ \begin{array}{l} T_c = \frac{1}{455 kHz} \\ T_{m,max} = 5 kHz \end{array} \right. \Rightarrow \tau_c = RC = \sqrt{T_c T_{m,max}} \hat{=} 21 \mu s \leftarrow \text{Design Value}$

pretty close

- $R_{12} \hat{=} 2.2 k\Omega \Rightarrow \tau_c \hat{=} 22 \mu s$
- $C_{10} \hat{=} 0.01 \mu F$

Rough Calculation also some interaction $C9/R11/C4$

d) Add Blocking Capacitor in series and After Detector

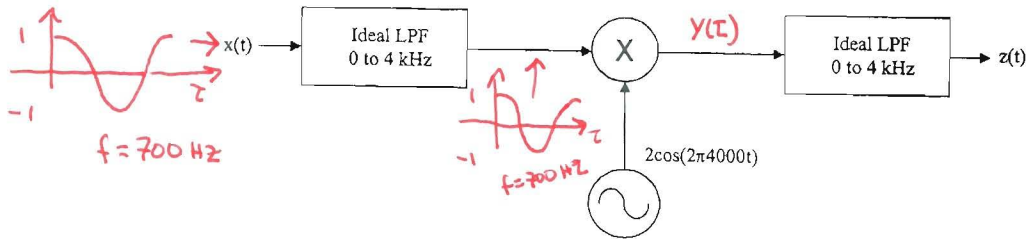
C11 serves this purpose on our AM Radio before Amp ALSO, C13 (Before Speaker)

e) $\text{Single Tone at } 14.3 kHz$

EE334 Homework PS8

Problem 3.5

Shown below is a simplified speech scrambler that can convert a voice signal, $x(t)$, into an unintelligible signal $z(t)$.



- If $x(t)$ is a pure tone test signal of 700 Hz with an amplitude of 1, determine $z(t)$.
- If $x(t)$ is now taken to be a full voice signal with frequency components from 50 Hz on up, sketch the spectrum of $z(t)$ and describe why it will be unintelligible. Assume a convenient symmetrical shape for the spectrum at the output of the first LPF.
- Explain in words and using a diagram how $z(t)$ can be changed back into $x(t)$ and hence unscrambled.

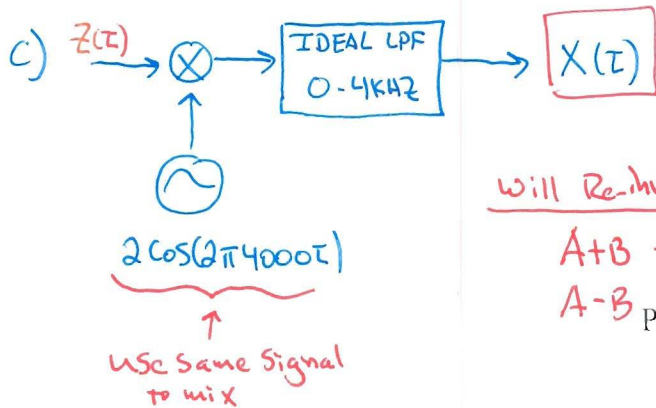
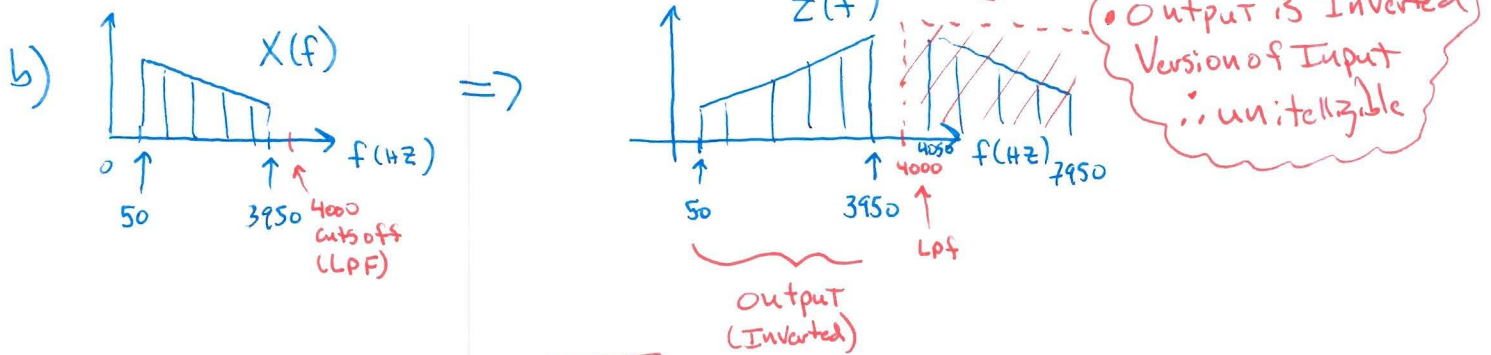
a) $Y(t) = \cos A \cdot 2 \cos B$

$$= \cos(2\pi \cdot 4700t) + \cos(2\pi \cdot 3300t)$$

$f_c + f_m$ $f_c - f_m$

$* \cos A \cos B = \frac{1}{2} [\cos(A+B) + \cos(A-B)]$
 $f_c = 4000 \text{ Hz}$
 $f_m = 700 \text{ Hz}$

$Z(t) = \cos(2\pi \cdot 3300t)$



Will Re-invert

$A+B \rightarrow 4000+3950 = 7950 \text{ Hz (LPF)}$
 $A-B \rightarrow 4000-3950 = 50 \text{ Hz} + \text{others}$
 original signal