1. For the AM signal, $v_{AM}(t)$ shown in Figure T5.1
(a) Determine V_S, V_C, f_S, f_C.
(b) Calculate the modulation index, m
(c) Write the equation for the modulating signal, $v_S(t)$
(d) Write the equation for the AM signal, $v_{AM}(t)$
(e) Sketch the single-sided amplitude spectrum of $v_{AM}(t)$
(f) Calculate the bandwidth of $v_{AM}(t)$

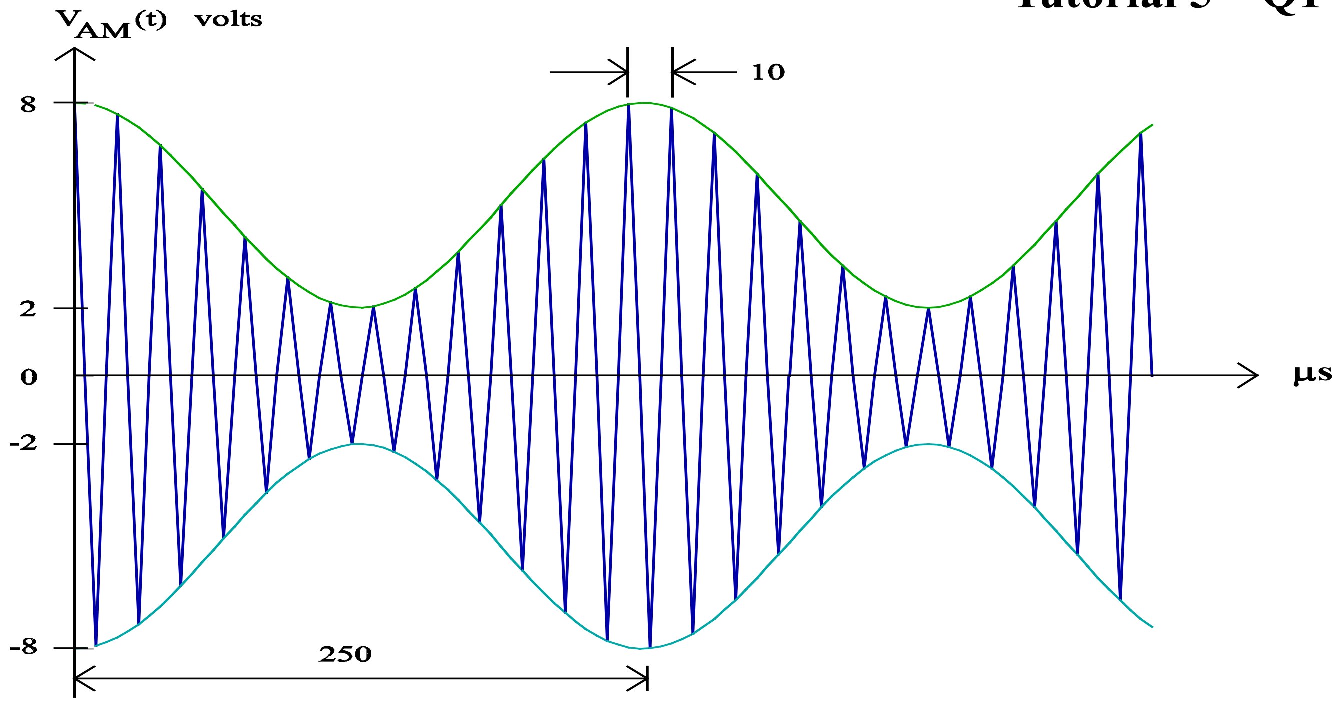
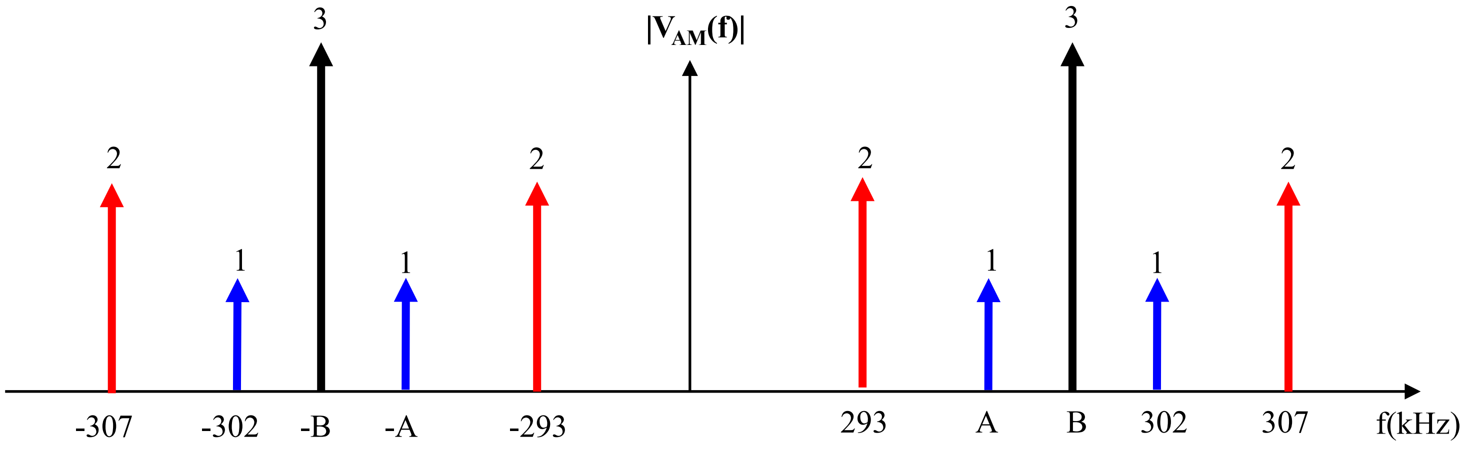


Figure T5.1 An AM signal

Guided Solution

1. Determine if it is single-tune AM.
2. Locate the positive envelope and determine V_S from the Peak-Peak amplitude of the positive envelope.
3. Determine V_C by finding the voltage of the middle of the positive envelope.
4. Calculate f_S from the period of the positive envelope.
5. Locate the carrier and calculate f_C from the period of the carrier.
6. Calculate m from V_S and V_C.
7. Substitute the values obtained into the standard equation for modulating signal and AM signal.
8. Substitute the values obtained into the standard AM spectrum.
9. Repeat steps 5-8 until the combination with the lowest overall factor is found.

2. The AM signal spectrum is shown in Figure T 5.2.
   (a) Determine the frequency values of A and B.
   (b) Sketch the spectrum of the modulating signal and state its bandwidth.
   (c) Write the equation for the modulating signal.



Guided Solution

1. Compare Figure T.5.2 with the standard double-sided multi-tone AM spectrum (Figure 5.9 from the notes) to determine A and B.
2. Locate the frequency components of the modulating signal.
3. Determine the frequency and amplitude of all the frequency components of the modulating signal.
4. Substitute the values obtained into the standard multi-tone modulating signal.

5. Sketch the double-sided spectrum of an AM signal, $v_{AM}(t)$ whose carrier $v_C(t) = V_C\cos\omega_C t$ is modulated by the modulating signal, $v_S(t)$.

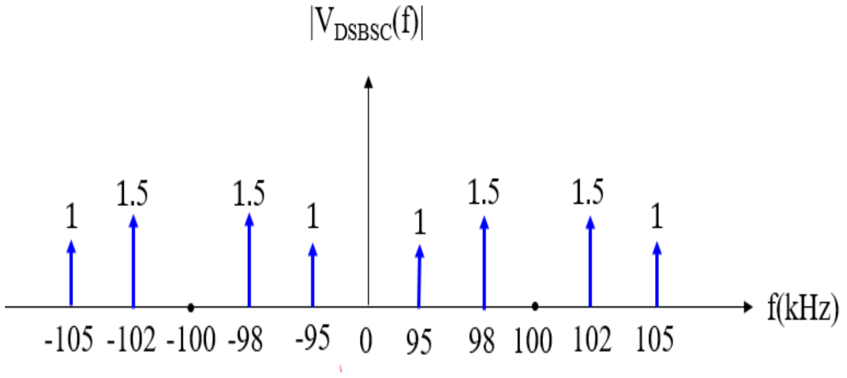
$$v_S(t) = V_1\cos\omega_1 t + V_2\cos\omega_2 t + V_3\cos\omega_3 t \quad \text{where } V_1 > V_2 > V_3 \text{ and } f_3 > f_2 > f_1$$

Guided Solution

1. Find the frequency and amplitude of each frequency component of the modulating signal.
2. Represent each frequency component by a spectrum line to obtain the single-sided amplitude spectrum of the modulating signal.
3. Covert the single-sided amplitude spectrum to double-sided amplitude spectrum.
4. Shift the double-sided amplitude spectrum right and left by f_C to obtain the double-sided spectrum of the AM signal.

Tutorial 5 – Q7

7. If the modulated signal in Q6 is fed to the circuit in Figure T5.7,
   (a) sketch the spectrum at V_X and V_o. Given that frequency of $v_C(t)$ in Figure T5.7 is 100 kHz and the cut-off frequency of the LPF is 6 kHz.
   (b) If the frequency of the carrier at the demodulator in Figure T5.4 is offset by 1kHz, what is the effect on the output?



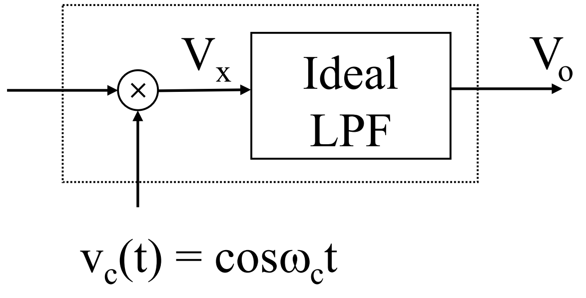


Figure T5.7

Guided Solution

(a)

1. Signal at V_X is the product of the input signal and $\cos\omega_c t$.
2. Applying the knowledge that multiplying a signal by $\cos\omega_c t$ is equivalent to shifting the signal spectrum left and right by f_C.
3. Shift the spectrum shown in the figure left by 100 kHz and right by 100 kHz with the amplitude of each component halved.
4. Calculate the frequency of each frequency component at the new location.
5. Determine the passband of the ideal LPF.
6. Remove all the frequency components that are stopped by the ideal LPF to obtain the spectrum at V_o.

(b)

1. Let the new carrier frequency $f_{cnew} = f_c + 1$, or $f_{cnew} = f_c - 1$.
2. Repeat step 3-6 of part (a) using the new carrier frequency f_{cnew} .
3. Observe the difference in the frequencies compared with those obtained in (a).