ANALYTIC SOLUTION;

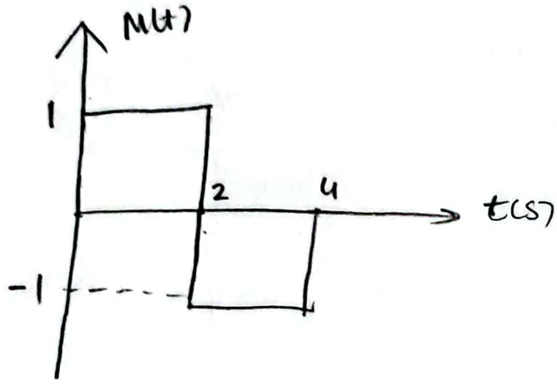
$$m(t) = \Pi\left(\frac{t-1}{2}\right) - \Pi\left(\frac{t-3}{2}\right)$$

$$A.\Pi\left(\frac{t}{\tau}\right) \xrightarrow{F} A\tau\,\mathrm{sinc}(\tau f)$$

$$m(t) \xrightarrow{F} M(f)$$

$$|M(f)| = 2\mathrm{sinc}(2f) - 2\mathrm{sinc}(2f)$$

We get magnitude spectrum.



FM modulation

$$\phi(t) = 2\pi k_f \int_{-\infty}^{t} m(\tau)d\tau \quad , k_f = 50$$

$$\int_{-\infty}^{t} m(\tau)d\tau = \int_{0}^{t} m(\tau)d\tau = t\Big|_0^2 + (-t)\Big|_2^4 \Longrightarrow \text{Max Value} = \underline{\underline{2}}$$

$$\phi(t) = 2.\pi.50.\left(t\Big|_0^2 + (-t)\Big|_2^4\right)$$

$$\mathrm{Max}\{\phi(t)\} \cong 628{,}31$$

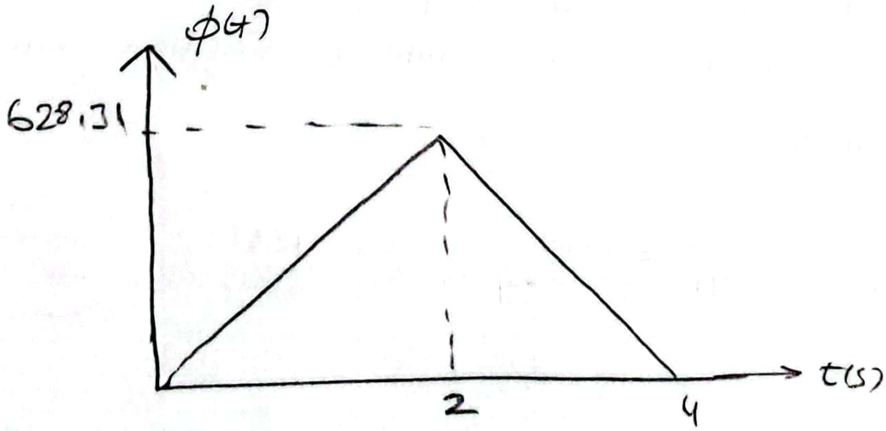


Figure 3 and analytic solution are same.

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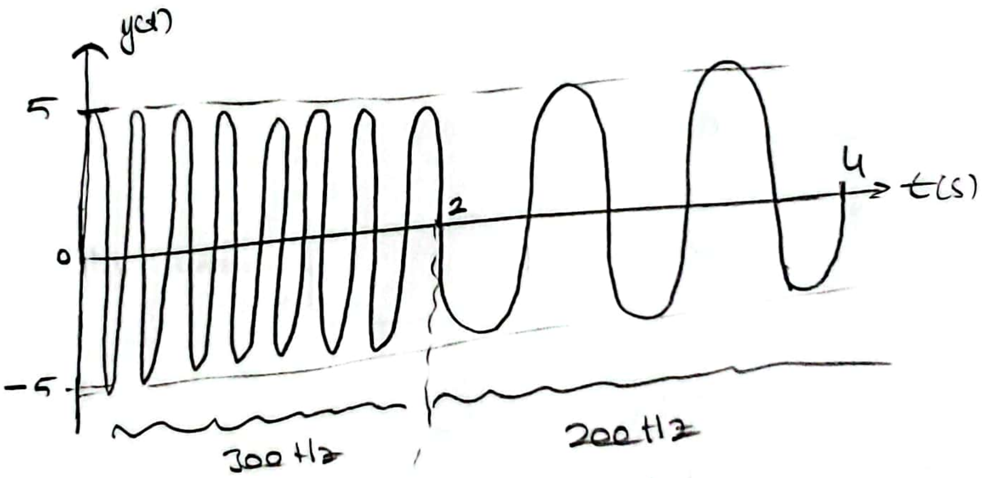
$$y(t) = 5\cos(500\pi t + \phi(t))$$
$$= 5\cos\left(500\pi t + 2\pi k_f \int_{-\infty}^{t} m(\tau)\,d\tau\right)$$

In the time domain 0 to 2 integral is t, after 2 second integral is $-t$. We found the analytically $\int_{-\infty}^{t} m(\tau)\,d\tau$. In the 0 to 2 second frequency increas, because phase is pozitive. In the 2 to 4 phase is negative.

In 0 to 2 $\longrightarrow$ $y(t) = 5\cos(500\pi t + 2\pi.50.t)$
$= 5\cos(600\pi t)$
$= \underline{5\cos(2\pi 300t)}$ $\longrightarrow$ freq $= 300$ Hz

In 2 to 4 $\longrightarrow$ $y(t) = 5\cos(500\pi t - 2\pi 50t)$
$= 5\cos(400\pi t)$
$= \underline{5\cos(2\pi 200t)}$ $\longrightarrow$ freq $= 200$ Hz



In the figure 4, the frequency difference is seen more clearly. The simulation was consistent with our analytical solutions.

Demodulator

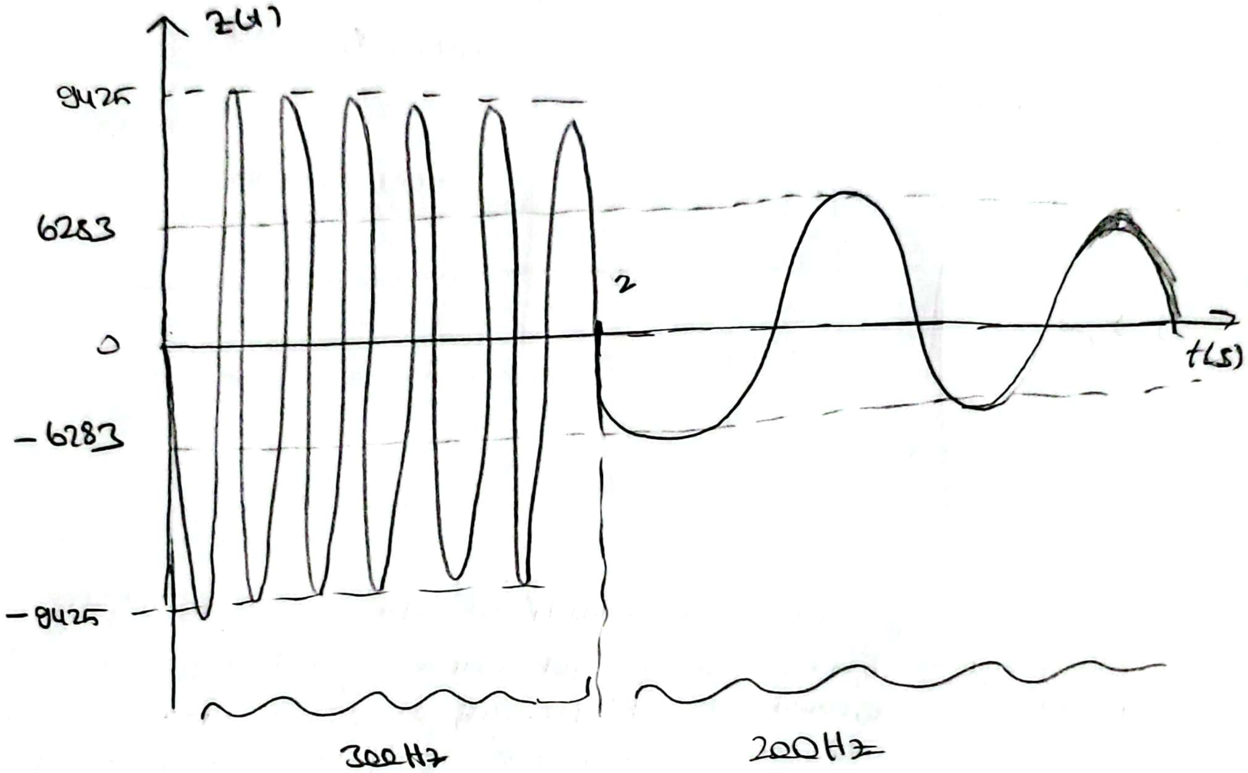
$$z(t) = \frac{dy(t)}{dt}$$

0 to 2 $\longrightarrow \frac{d[5\cos(600\pi t)]}{dt} = -600\pi \cdot 5\sin(600\pi t)$

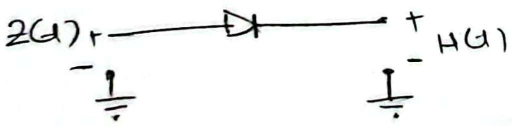
$\cong -9425\sin(600\pi t)$

2 to 4 $\longrightarrow \frac{d(5\cos(400\pi t))}{dt} = -400\pi\, 5\sin(400\pi t)$

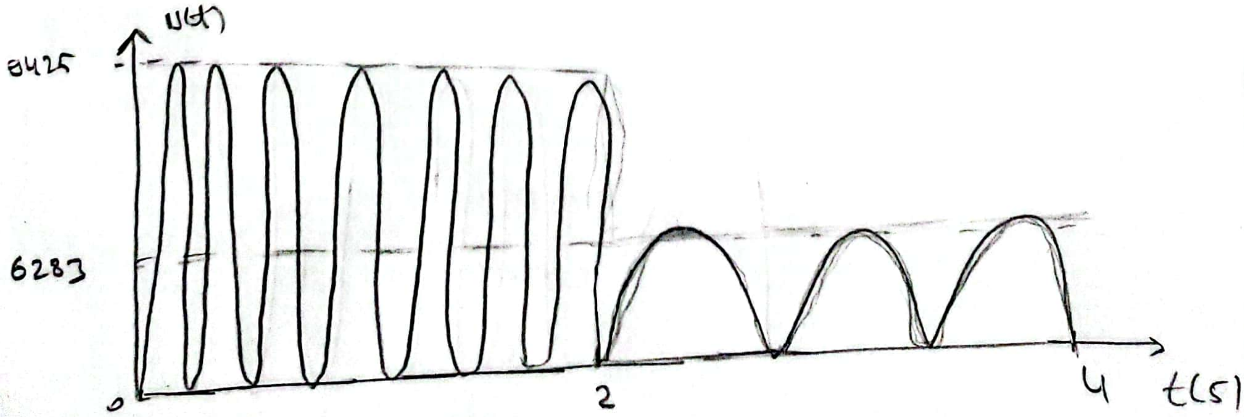
$\cong -6283\sin(400\pi t)$



z(t) analytic and figure 6 are same signal.



The upper half-wave is taken by ideal diode. (w(t))



This graph and figure 7 is same.

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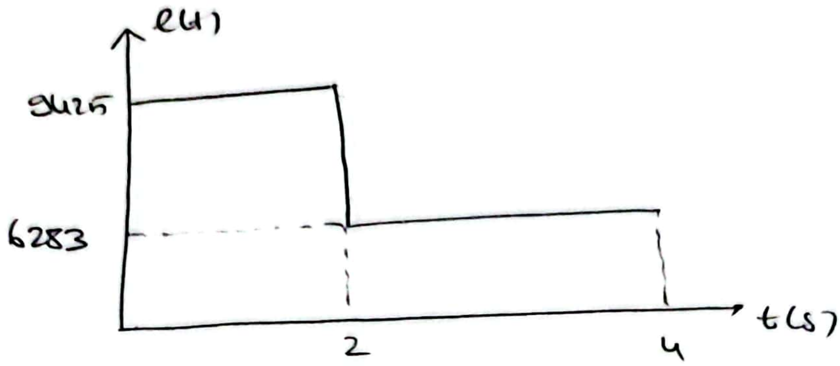
$v(t) \longrightarrow \boxed{LPF} \longrightarrow e(t)$

When we pass the signal obtained from the diode through a low-pass filter, we maked an envelope detector. The envelope of $v(t)$ signal is taken as follows



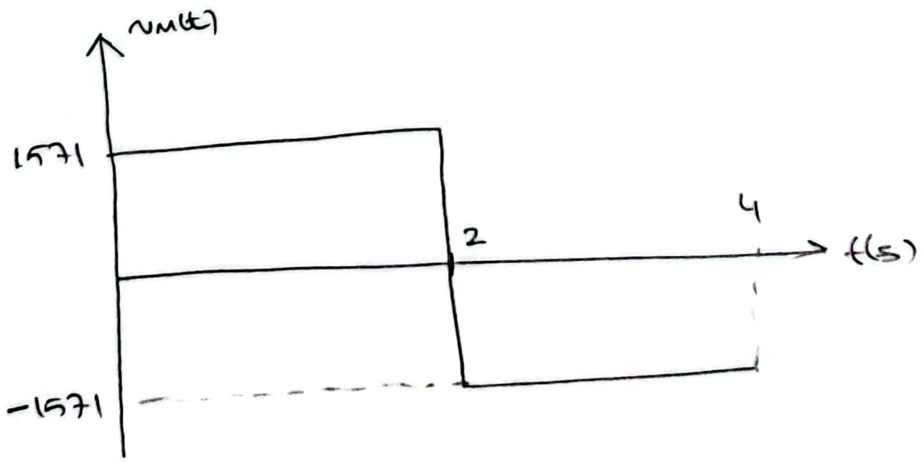
$e(t) \longrightarrow \boxed{\text{DC Block}} \longrightarrow \tilde{m}(t)$ (demodulated message signal)

DC blocking is done with a series capacitor. When the capacitor is considered ideal, DC blocking can be performed by taking the average of the minimum and maximum values

$$\frac{\text{Max. value} + \text{min. value}}{2} = \frac{9425 + 6283}{2} = 7854$$

New Max value $\rightarrow$ $9425 - 7854 = 1571$

New min value $\rightarrow$ $6283 - 7854 = -1571$



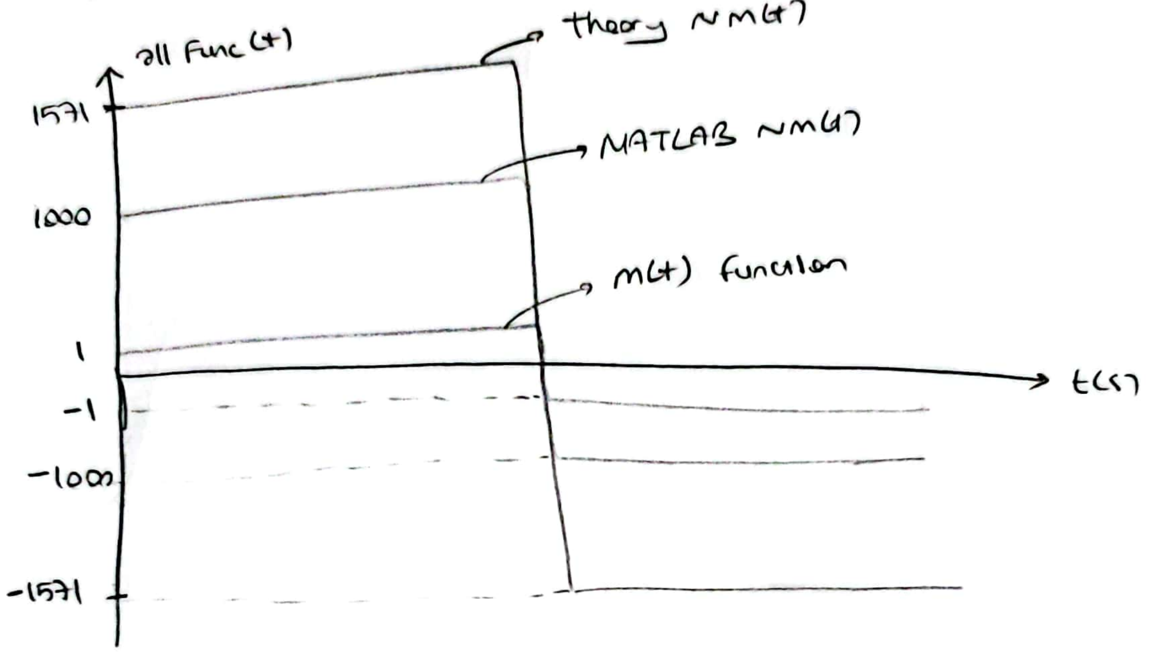
$\tilde{m}(t) = 1571\, m(t)$

Found in theory.

In the MATLAB;

$N m(t) \cong 1000 m(t)$

Comparison;



Theoretically, since the bandwidth of the signal is infinite in the frequency domain, we can get entire signal higher. In MATLAB simulation since we could not get the full power in all bands, a lower amplitude signal was received, but the signal was not distorted.

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