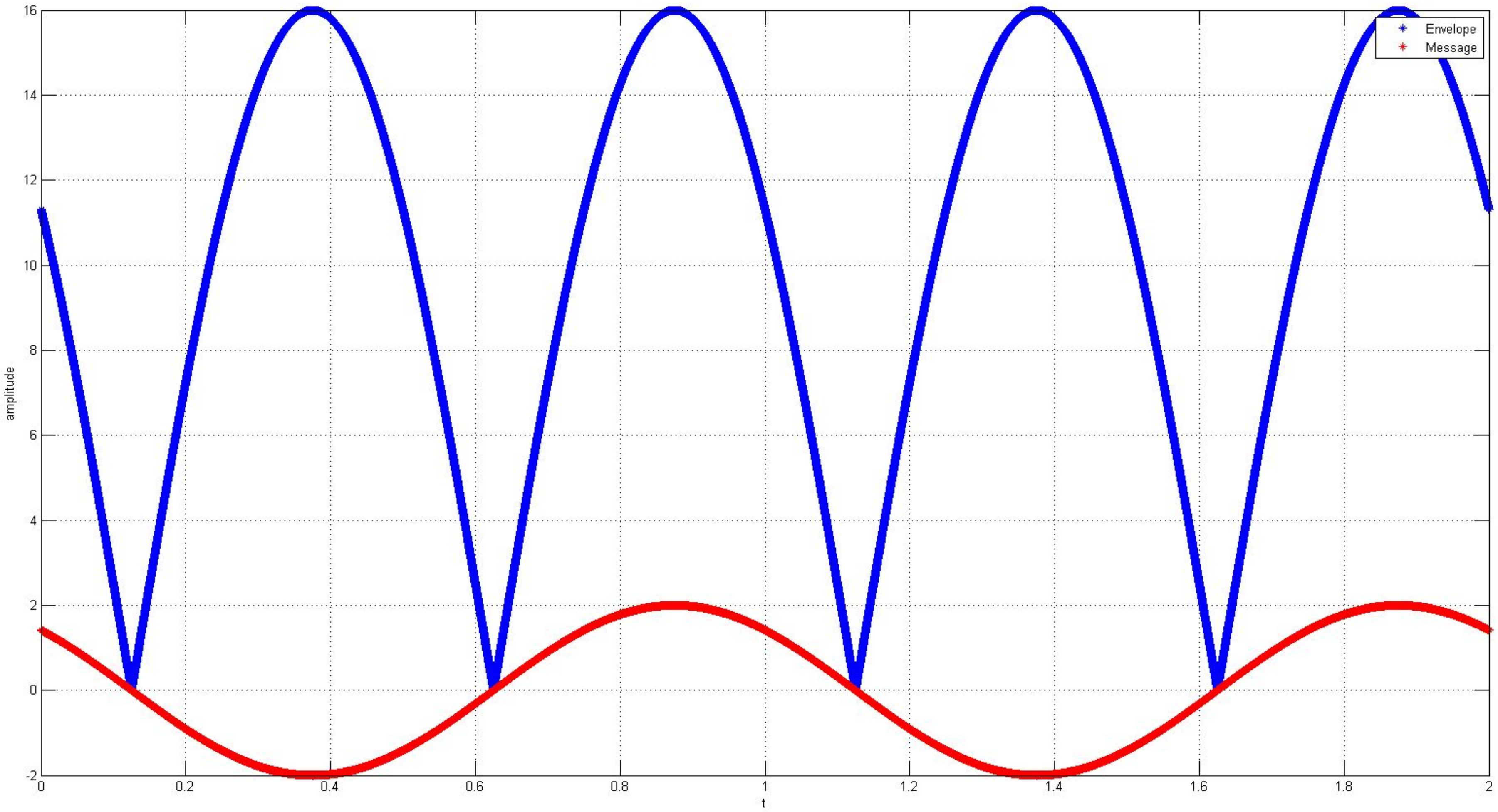
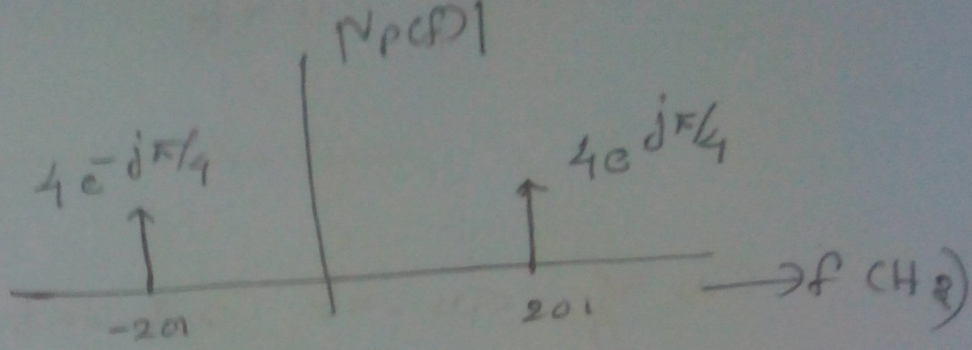
1 a)

$$\text{Power} = 4^2 \cdot 4 = \underline{\underline{64}}$$



Envelope
Message
amplitude
t
16
14
12
10
8
6
4
2
0
-2
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2

1 c) after high pass filtering $u(t)$, the spectrum is



So $v_p(t) = 4\cos(201 \times 2\pi t + \pi/4)$

$= 4\cos(400\pi t + (2\pi t + \pi/4))$

$\Longrightarrow v_c(t) = 4\cos(2\pi t + \pi/4)$

$v_s(t) = 4\sin(2\pi t + \pi/4)$

The envelope is this 1 Hz (low freq) component and can be sketched easily.

Edit: The coefficient of cos and sin term in V_c and V_s respectively are 8 and not $\underline{\underline{4}}$.

Q.2. a).

$$m(t) = \underset{(*)}{3\cos(2\pi t)} + \underset{(**)}{4\sin(6\pi t)}$$

Unit of t is milliseconds.

~~f_1 is given by~~

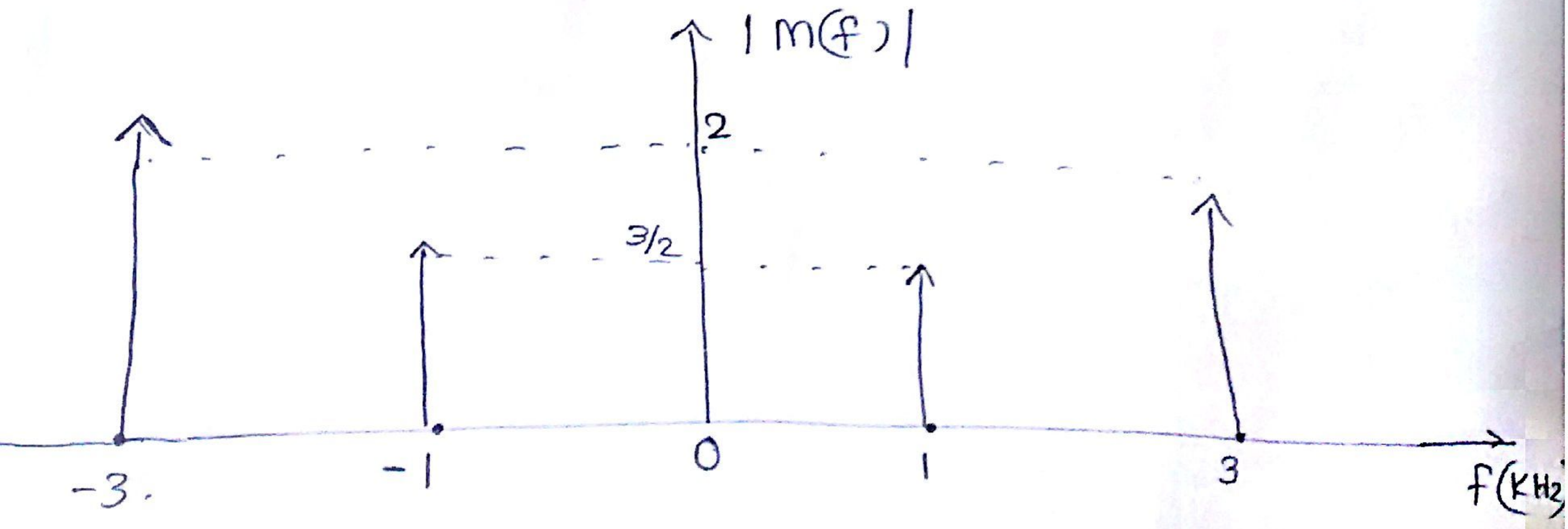
time for one complete cycle in $(*)$ is $1\,ms \Rightarrow f_1 = 1\,KHz$.

" " " " " in $(**)$ is $\frac{1}{3}\,ms \Rightarrow f_2 = 3\,KHz$.

Hence.

$$M(f) = \frac{3}{2}\,\delta(f - f_1) + \frac{3}{2}\,\delta(f + f_1)$$

$$+ 2\,\frac{\delta(f - f_2) - \delta(f + f_2)}{j}$$



Band width = 6 KHz.

2)

b) $$m_n(t) = \frac{m(t)}{\left|\min_t m(t)\right|}$$

$$\min_t m(t) = \min_t \left(3\cos 2\pi t + 4\sin 6\pi t\right)$$

$$= -6.62$$

$$m_n(t) = 0.4532\cos(2\pi t) + 0.6042\sin(6\pi t)$$

c) $a_{mod} = 0.5$

$$\Rightarrow u_{AM}(t) = A_c\left(1 + a_{mod}\, m_n(t)\right)\cos(2\pi f_c t)$$

$$= A_c\left(1 + 0.5\left(0.4532\cos(2\pi t) + 0.6042\sin 6\pi t\right)\right)\cos 2\pi f_c t$$

$$u_{AM}(t) = A_c\left(1 + 0.2266\cos(2\pi t) + 0.3021\sin(6\pi t)\right)\cos 2\pi f_c t$$

2 (d)

$m_n(t) = 0.4532 \cos(2\pi t) + 0.6042 \sin(6\pi t)$

$$\overline{m_n^2} = \frac{1}{2}(0.4532)^2 + \frac{1}{2}(0.6042)^2$$

$$= 0.1026 + 0.1825$$

$$= 0.2851$$

$$\eta_{AM} = \frac{a_{mod}^2 \times \overline{m_n^2}}{1 + a_{mod}^2 \overline{m_n^2}}$$

(Here $a_{mod} = 1/2$)

$$= \frac{\left(\frac{1}{2}\right)^2 \times 0.2851}{1 + \left(\frac{1}{2}\right)^2 \times 0.2851}$$

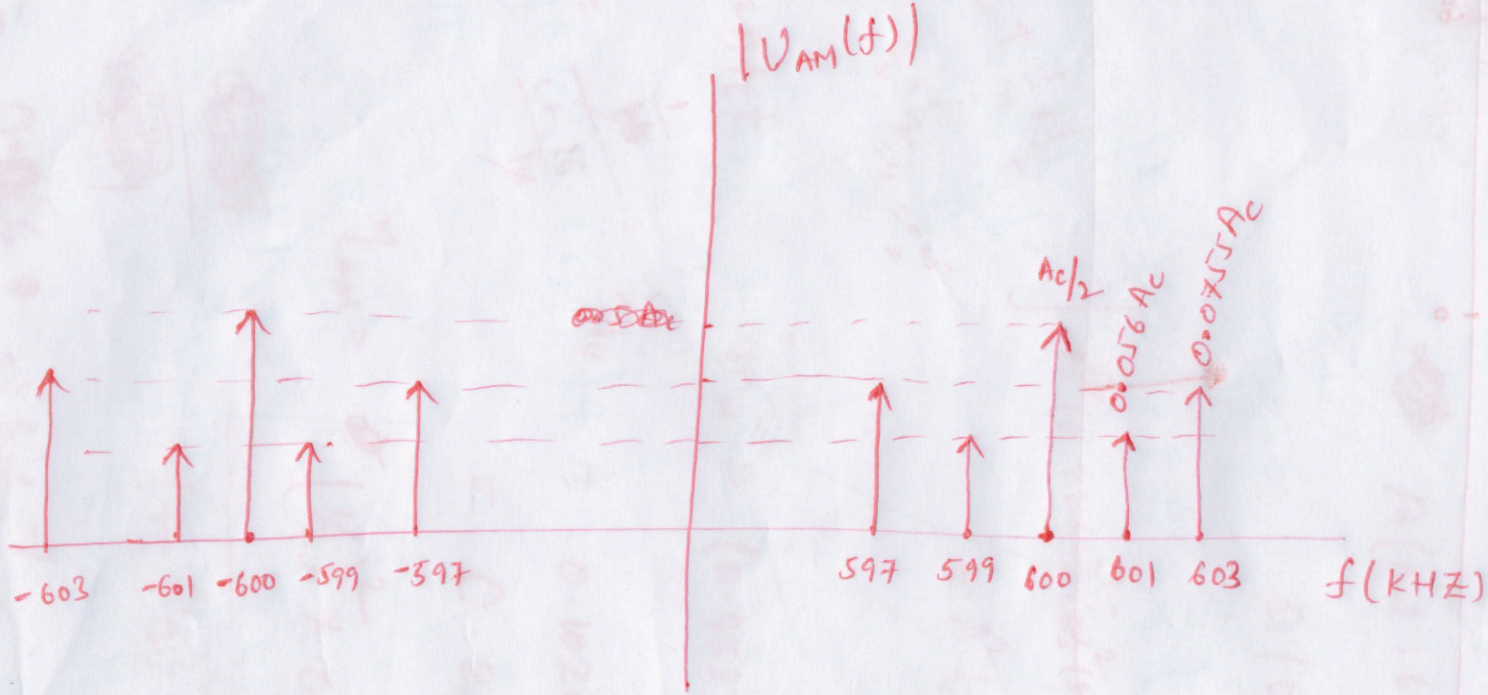
$$= 0.066$$

$\Rightarrow$ 6.6% (Power efficiency)

2e

Carrier freq = 600 kHz

$m_n(t) = 0.4532 \cos(2\pi t) + 0.6042 \sin(6\pi t)$



$\frac{A_c}{4} \times a_{mod} \times 0.453$ ($a_{mod} \to 1/2$)

$= 0.05$

$\frac{A_c}{4} \times a_{mod} \times 0.604$

$= 0.075$

2(f). Bandwidth of message signal ~~B = 1/2 kHz~~

$f_c = 600$ KHz. $B = 6\,kHz$

$R = 50\Omega$

We know that for an envelope detector

$$\frac{1}{f_c} \ll RC \ll \frac{1}{B}$$

$$\frac{1}{600\times10^3} \ll 50C \ll \frac{1}{6\times10^3}$$

$$\boxed{333.33\,\mu F \ll C \ll 3.33\,\mu F}$$

(3a)

$$m(t) = \cos(2\pi f_m t + \phi) \qquad \boxed{\text{DSB-SC}}$$

$$u_p(t) = A\, m(t) \cos 2\pi f_c t \qquad f_c > f_m$$

Spectra of corresponding LSB and USB.

Passband signal: $u_{DSB}(t) = A\, m(t) \cos 2\pi f_c t$

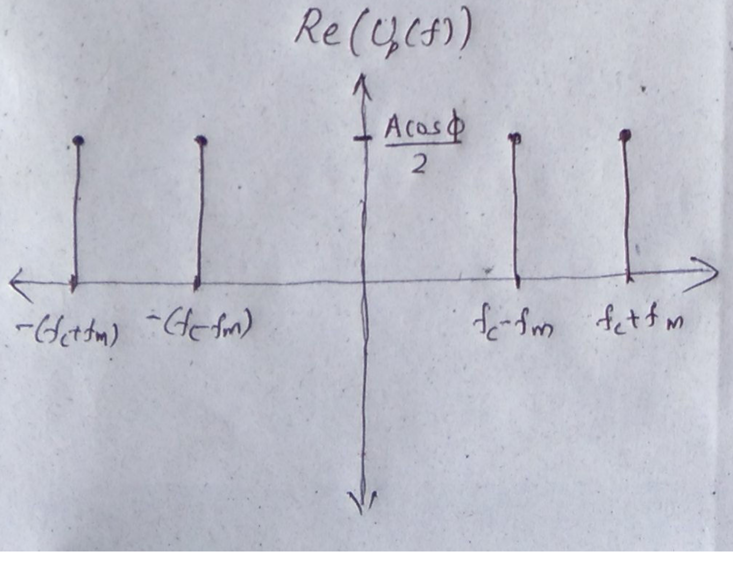
$$= A \cdot \cos(2\pi f_m t + \phi) \cos(2\pi f_c t)$$

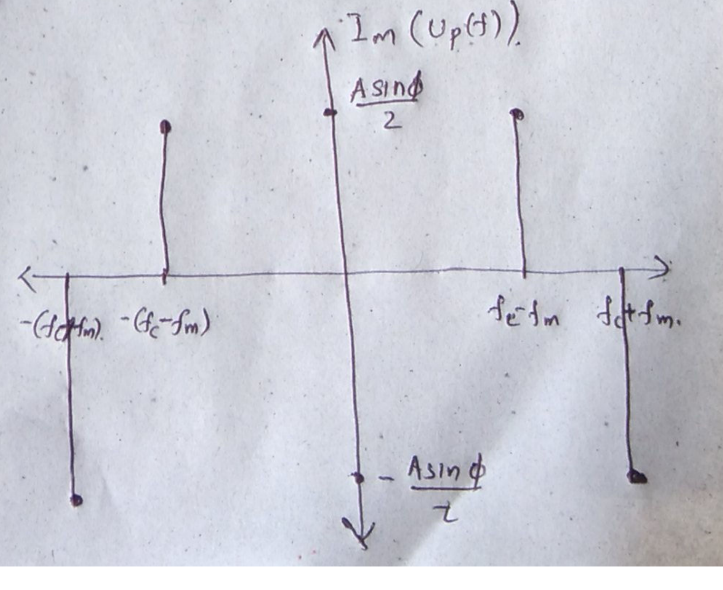
$$= A \cdot \left[\cos(2\pi f_m t)\cos\phi - \sin(2\pi f_m t) \cdot \sin\phi\right] \times \cos 2\pi f_c t$$

$$= A\cos\phi \cdot (\cos 2\pi f_m t \cdot \cos 2\pi f_c t) - A\sin\phi \cdot (\sin 2\pi f_m t \cdot \cos 2\pi f_c t)$$

$$= \frac{A\cos\phi}{2}\left[\cos(2\pi(f_c - f_m)t) + \cos(2\pi(f_c + f_m)t)\right] - \frac{A\sin\phi}{2}\left[\sin(2\pi(f_m + f_c)t) + \sin(2\pi(f_m - f_c))t\right]$$

$$= \frac{A\cos\phi}{2}\cos(2\pi(f_c - f_m)t) + \frac{A\cos\phi}{2}\cos(2\pi(f_c + f_m)t) - \frac{A\sin\phi}{2}\sin(2\pi(f_m + f_c)t) + \frac{A\sin\phi}{2}\sin(2\pi(f_c - f_m)t)$$





3) b $m(t) = \cos(2\pi f_m t + \phi)$

$U_p(t) = A \cdot m(t) \cos 2\pi f_c t$

$$U_p(t) = A \cos(2\pi f_m t + \phi) \cos(2\pi f_c t)$$

$$= \frac{A}{2}\left[\cos(2\pi f_c t + 2\pi f_m t + \phi) + \cos(2\pi f_c t - 2\pi f_m t - \phi)\right]$$

$$U_p(t) = \frac{A}{2}\cos(2\pi t(f_c + f_m) + \phi) + \frac{A}{2}\cos(2\pi t(f_c - f_m) - \phi)$$

The first term here is the USB term,
2^{nd} term here is the LSB term

$$USB = \frac{A}{2}\cos(2\pi t(f_c + f_m) + \phi)$$

$$LSB = \frac{A}{2}\cos(2\pi t(f_c - f_m) - \phi)$$