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D9A/47

PCE Assignment 2

1) Define AM and modulation index of AM?

⇒ Definition:- Amplitude modulation is a technique of modulation, in which amplitude of carrier varies in accordance with amplitude of modulating signal, keeping frequency and phase constant.

Modulation index (m) is defined as the ratio of amplitudes of modulating signal to the carrier signal.

$$M.I = \frac{\text{Modulating Signal Amplitude}}{\text{Carrier Signal Amplitude}}$$

$$\boxed{m = \frac{E_m}{E_c}}$$

$$m = \frac{V_{max} - V_{min}}{V_{max} + V_{min}}$$

2) Derive the mathematical expression of AM.

⇒ Time domain expression of AM wave-

Modulating signal $= e_m = V_m \sin \omega_m t$ —— ①

Carrier signal $= e_c = V_c \sin \omega_c t$ —— ②

Amplitude modulated signal $= e_{AM} = A \sin \omega_c t$ —— ③

where $A = V_c + e_m$

$= V_c + (V_m \sin \omega_m t)$ —— ④

By putting eqn ④ into ③,

$e_{AM} = A \sin \omega_c t$

$e_{AM} = [V_c + (V_m \sin \omega_m t)] \sin \omega_c t$

$= V_c \sin \omega_c t [1 + (V_m/V_c \sin \omega_m t)]$

$e_{AM} = V_c \sin\omega_c t[1 + m \sin\omega_m t]$

where $m = \frac{V_m}{V_c}$ (modulation index)

This is called time domain representation of AM wave

8) What is Total power of AM, derive with expression.

→ Total power in AM (P_t):

P_t = (Carrier Power) + (Power in USB) + (Power in LSB)

$P_t = P_c + P_{USB} + P_{LSB}$

$\therefore \quad P_t = \frac{E^2_{carr}}{R} + \frac{E^2_{USB}}{R} + \frac{E^2_{LSB}}{R}$

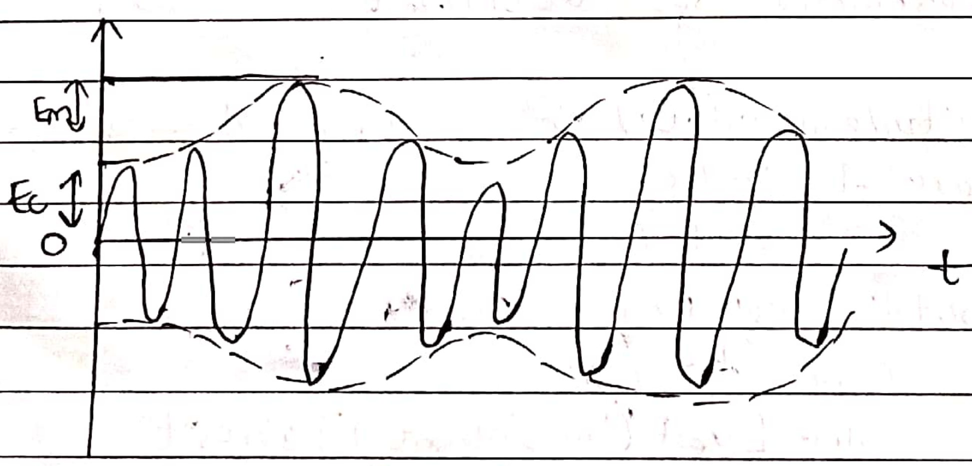
where, E_{carr}, E_{USB}, E_{LSB} = r.m.s values of carrier and side band ~~fr~~ amplitudes

R = charecteristic resistence of antenna in which total power is dissipated

1) What is the effect of modulation index on AM?

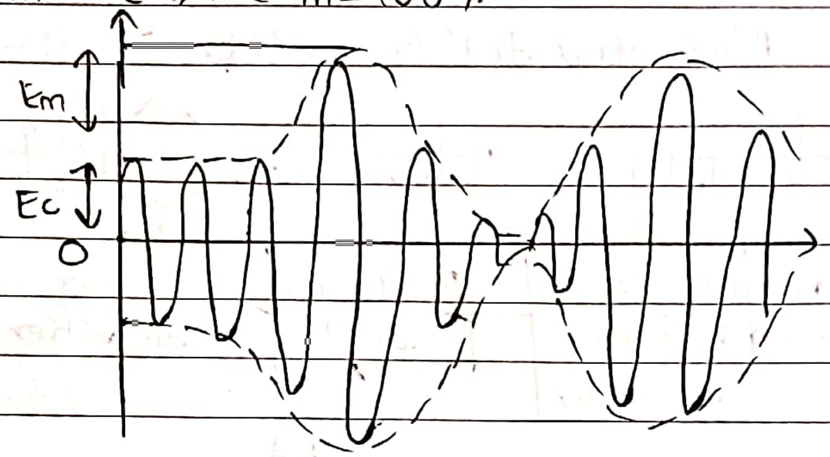
→ 1) For $m < 1$,

i.e $E_m < E_c$ (Undermodulation)



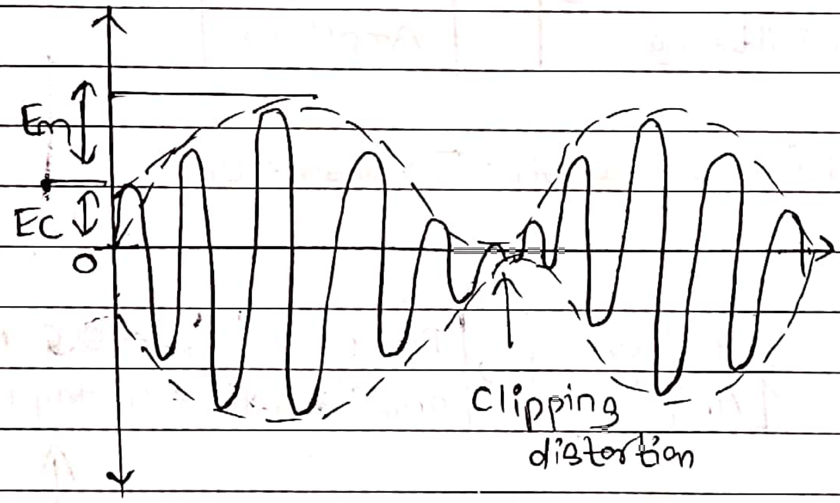
2) For $m = 1$ (Fully Modulated Wave):-

$E_m = E_c$, i.e. $m = 100\%$

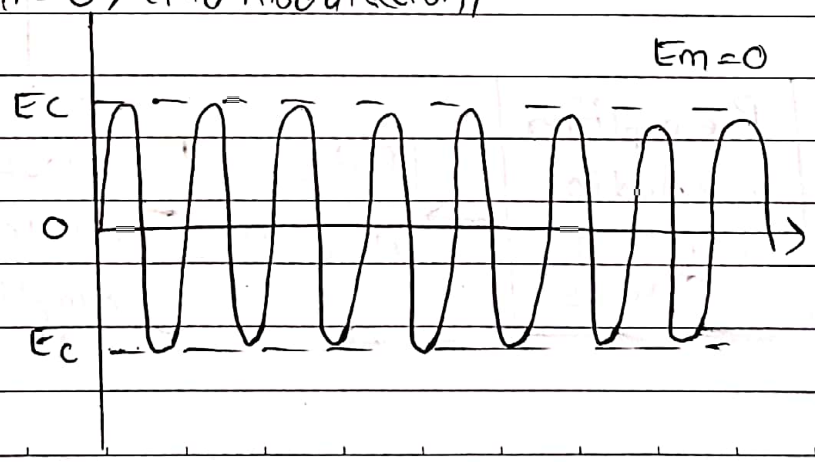


3) For $m > 1$, (Over Modulation)

$E_m > E_c$

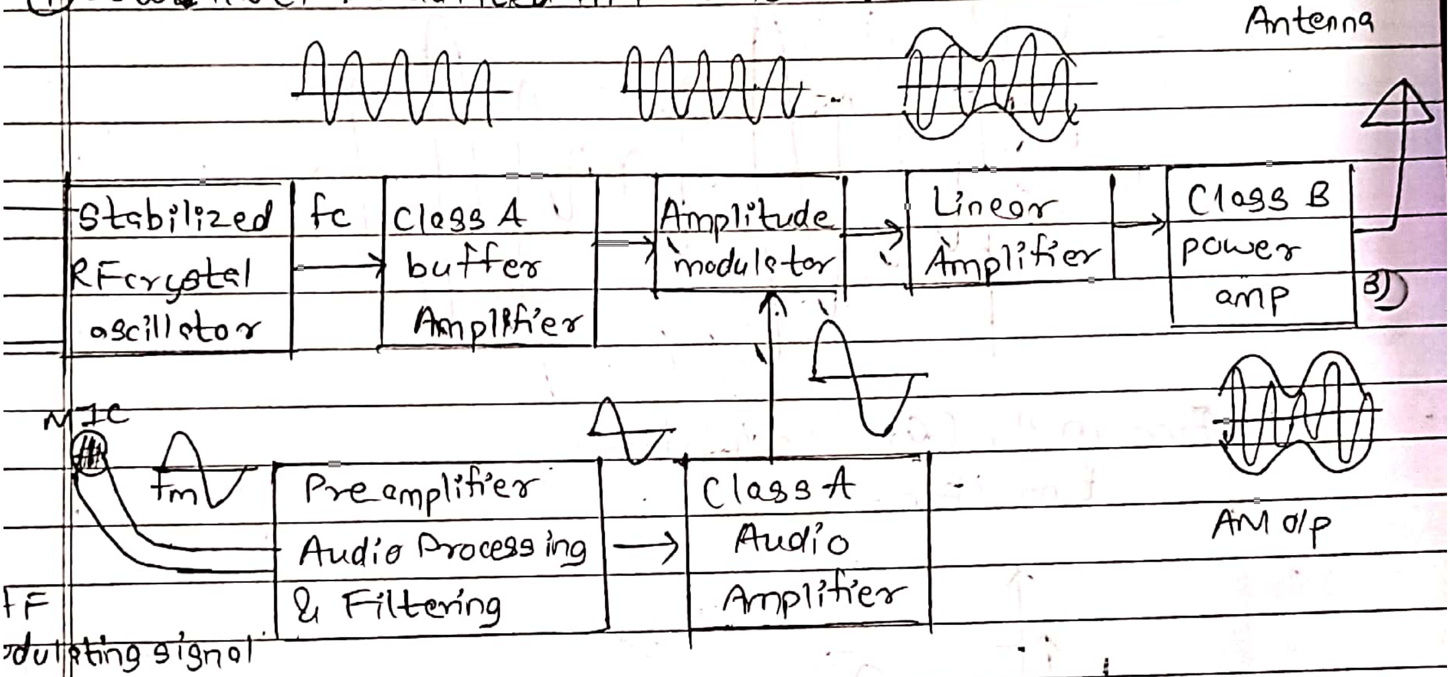


4). For $m = 0$, (No modulation)

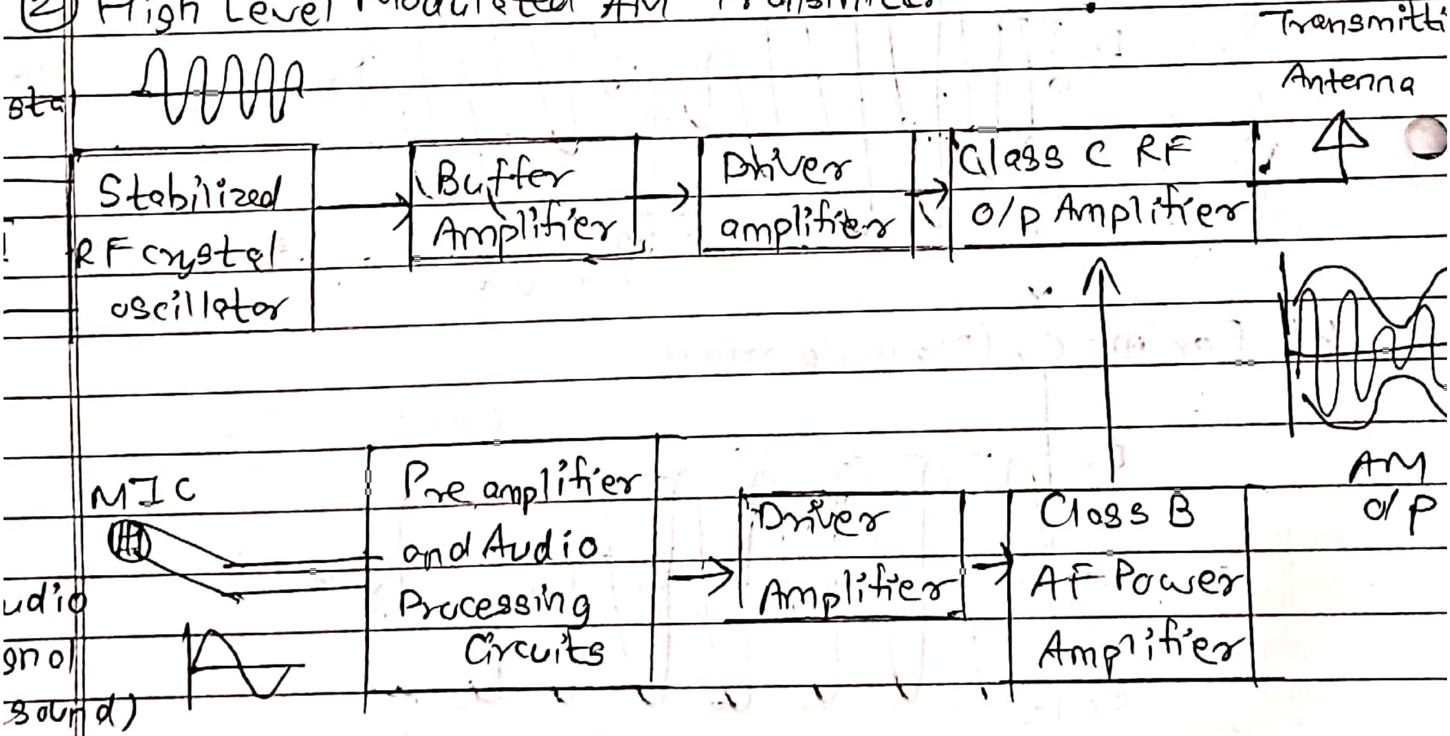


5) Explain High Level and Low Level AM Modulation

(1) Low level Modulated AM Transmitter :-



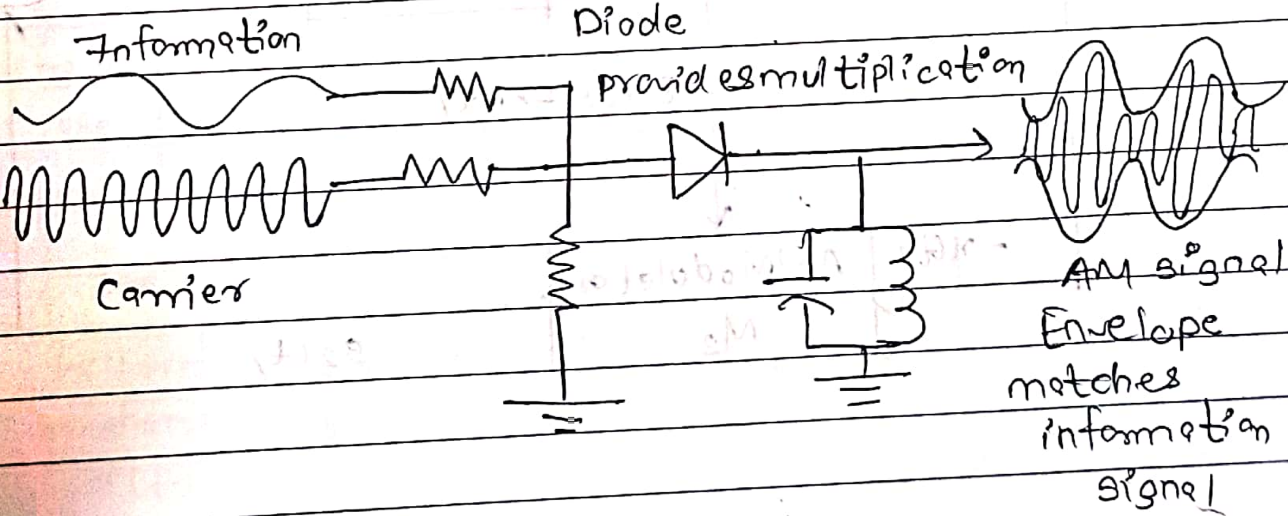
(2) High Level Modulated AM Transmitter



Compare High Level and Low level modulation

High Level modulation	Low level Modulation
① Modulation takesplace at high power level	① Modulation takes place at low power level
② Class - C amplifier are used which are highly efficient	② After modulation linear amplifiers (Class A, B, AB) are used.
③ Very high efficiency	③ Low efficiency than high level
④ Complex because of very high power	④ Easy because of low power
⑤ Used in high power broadcast transmitters.	⑤ Used in TV ~~m~~ transmitters (IF modulation method) lab equipments, walkie-talkie, e

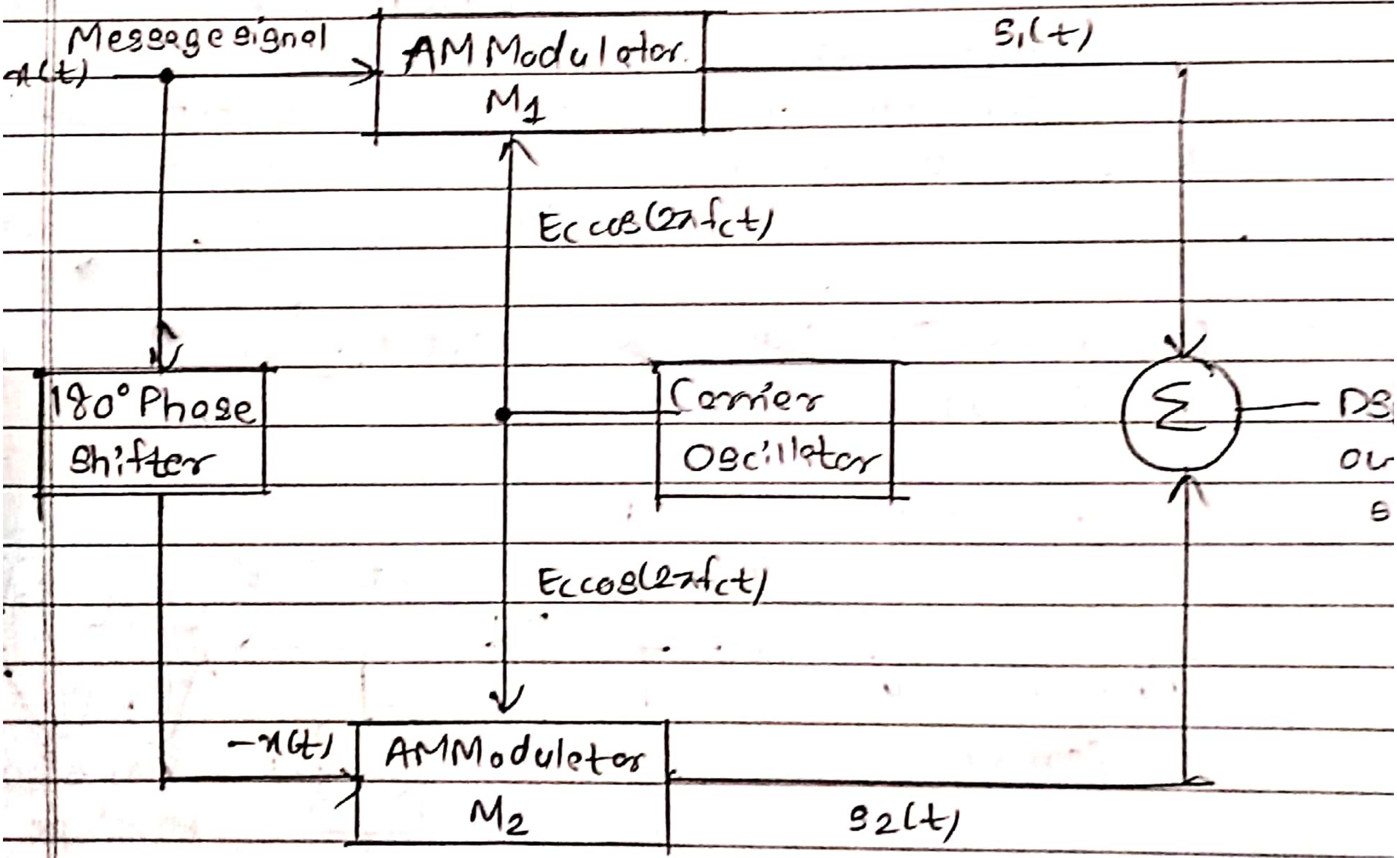
Explain generation of DSBFC using diode with neat diagram



Diode modulator

1. Diode modulator consists of resistive mixing network, a diode rectifier, LC tuned circuit
2. The carrier is applied to one input resistor and modulating signal to other
3. The resistive network causes two signals to linearly mix (i.e. algebraically add)
4. A diode passes half cycle when forward biased.
5. The coil and capacitor repeatedly exchange energy, causing an oscillation or ringing at resonant frequency.

2) DSB SC using Balance modulator:-



o/p of AM modulator M1,

$S_1(t) = E_c \cos\omega_c t\,(1 + m\cos\omega_m t)$

o/p of AM Modulator M2,

$S_2(t) = E_c \cos\omega_c t\,(1 - m\cos\omega_m t)$

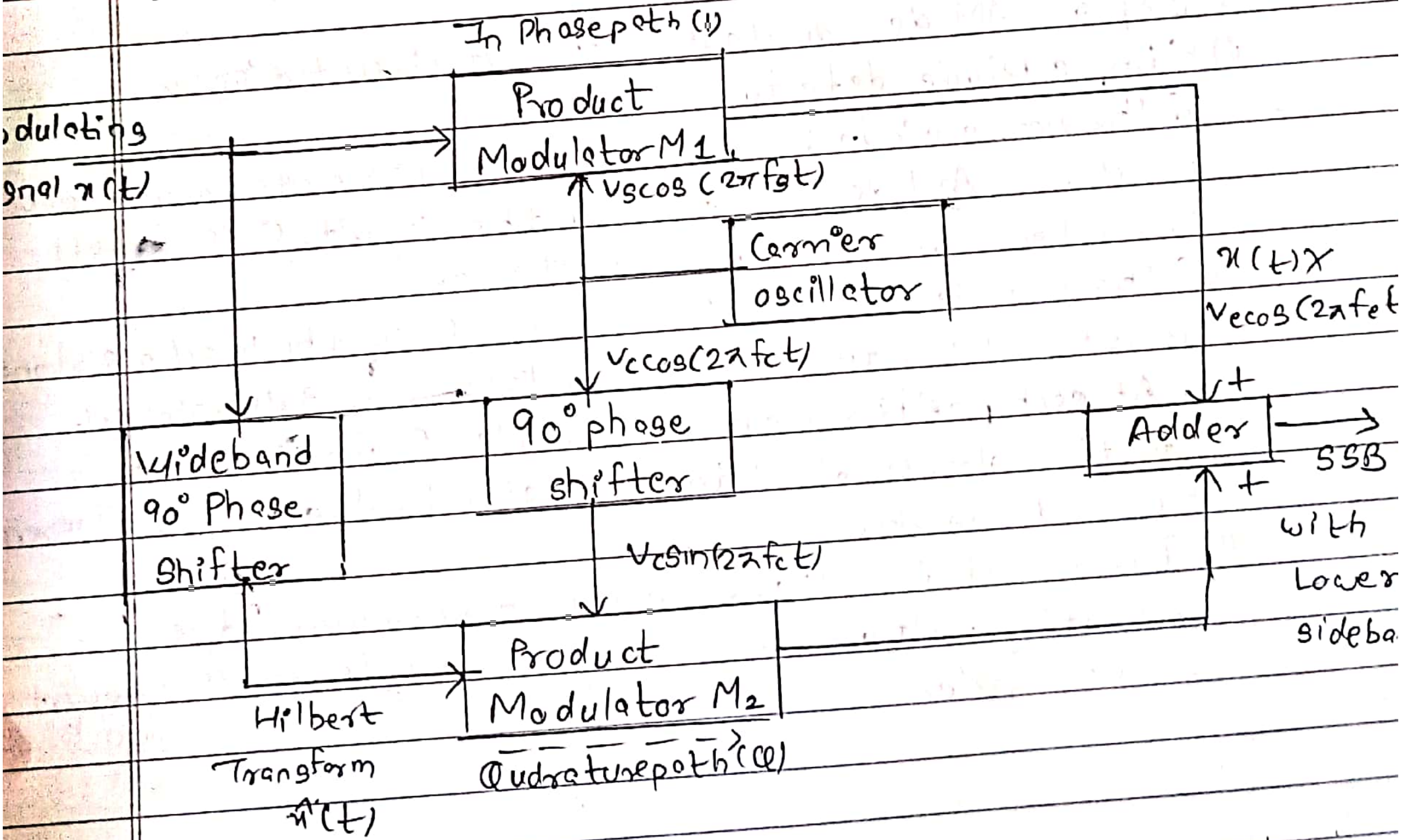
o/p of adder

$s(t) = s_1(t) + s_2(t)$

$= E_c \cos\omega_c t\,(1 + m\cos\omega_m t) + E_c\cos\omega_c t\,(1 - m\cos\omega_m t)$

$= 2m E_c \cos\omega_c t \cos\omega_m t \Rightarrow$ (DSBSC output)

3) SSBSC using phase shift method:

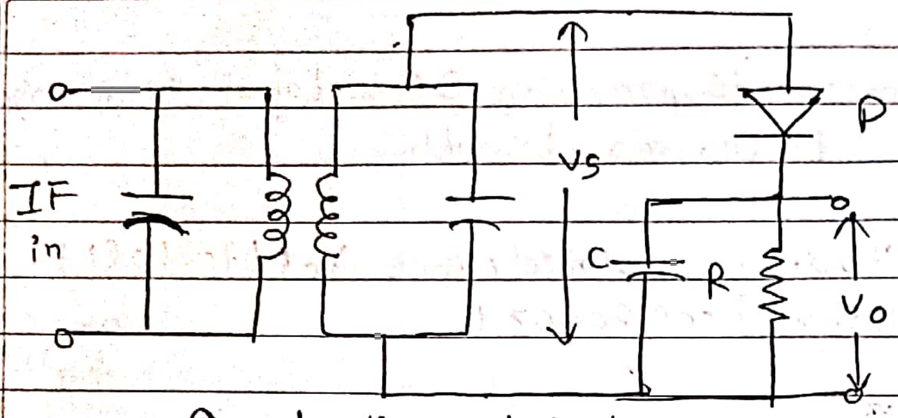


$x(t) = V_m \cos(2\pi f_m t)$
$\hat{x}(t) = V_m \sin(2\pi f_m t)$
o/p of Adder
$= x(t) V_c \cos(2\pi f_c t) + \hat{x}(t) V_c \sin(2\pi f_c t)$
Putting $x(t)$
$= V_m \cos(2\pi f_m t)[V_c \cos(2\pi f_c t)] + (-V_m \sin(2\pi f_m t))(V_c \sin(2\pi f_c t))$

$= V_m V_c (\cos(f_c - f_m) 2\pi t$ —— o/p is only LSB

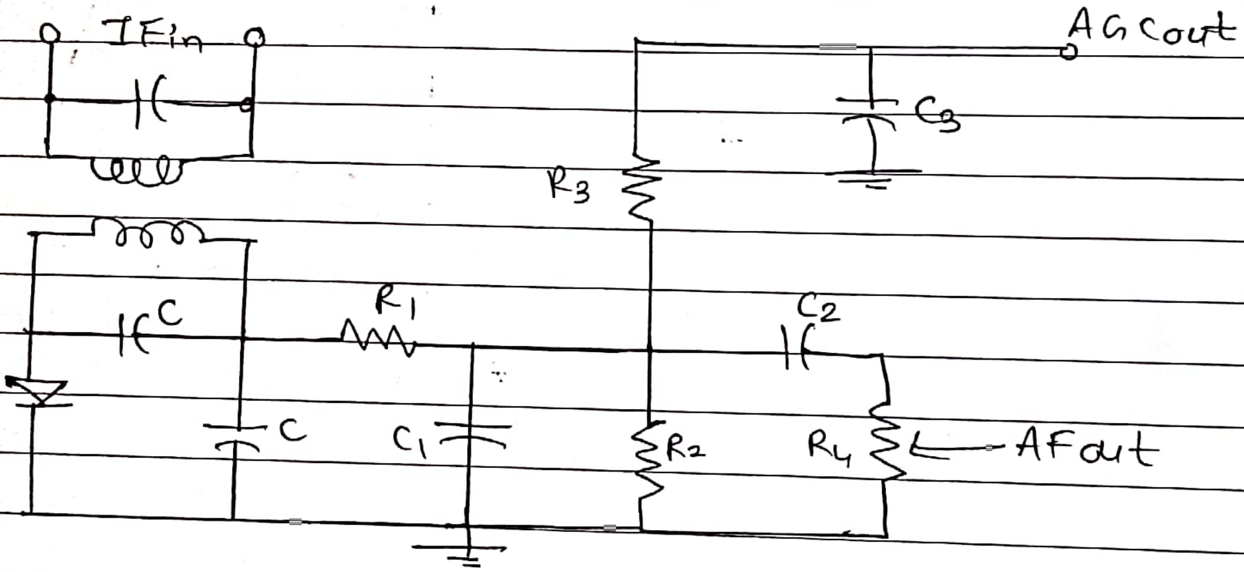
For USB o/p,
o/p of Adder must be,
$= x(t) V_c \cos(2\pi f_c t) - \hat{x}(t) V_c \sin(2\pi f_c t)$.

2) Explain AM demodulators with neat circuit diagram.
i) Simple Diode detector-
→ ① The simple diode detector is by far the most common device used for AM demodulation. On the circuit, C is small capacitance and R is large resistance.
② The parallel combination of R and C is the load resistance across which the rectified output V_o is developed.
③ At each positive peak of RF cycle, C charges up to a potential almost equal to peak signal voltage V_s, difference being diode drop.
④ The result is voltage V_o which reproduces the modulating voltage accurately, except for small amount of RF ripple.



Simple diode detector

ii) Practical diode detector-



→ ① The circuit operates as, the diode has reversed, so that now the negative envelope is demodulated.
② The resistor R has been split into two parts (R_1 and R_2) to ensure that there is a series DC path to ground for diode, but at same time a low pass filter has been added, in form of $R_1 C_1$. This removes any RF ripple present.
③ C_2 is coupling capacitor whose main function is to prevent diode dc output from reaching volume control R_4.
④ The combination $R_3 C_3$ is a lowpass filter designed to

remove AF components, providing DC voltage whose amplitude is proportional to carrier strength.

9) If an amplitude modulated wave $X_c(t) = 10(1 + 0.6\cos 200\pi t + 0.4\cos 400\pi t)\cos 2000\pi t$

1)