Envelope Detector :-

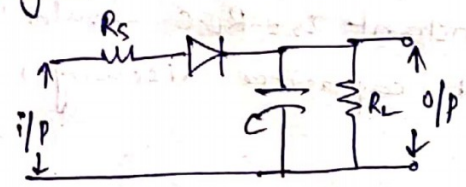
An envelope detector is a simple and yet highly effective device that is well-suited for the demodulation of AM signal, for which the percentage modulation is less than 100%. ($\mu < 1$).

Ideally, an envelope detector produces an output signal that follows the envelope of the i/p signal waveform exactly; hence the name.

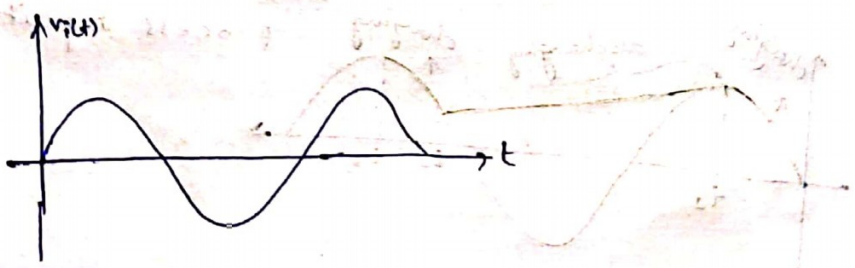
Envelope for some standard signals:

	ED i/p	ED o/p
1.	$V_m \cos 2\pi f_m t$ or $V_m \sin 2\pi f_m t$	V_m
2.	$A_c(1 + k_a m(t)) \cos 2\pi f_c t$	$A_c(1 + k_a m(t))$
3.	$A \cos 2\pi f_0 t + B \sin 2\pi f_0 t$	$\sqrt{A^2 + B^2}$

Ckt diagram :-



Let apply i/p as $v_i(t) = V_m \sin 2\pi f_0 t$



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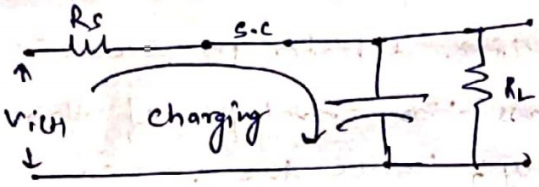
Case 1:-

For $t = 0^+$; voltage at p-side of p-n junction diode is greater than in n-side.

∴ diode is F.B. ⇒ short circuit

∴ equivalent ckt diagram:-

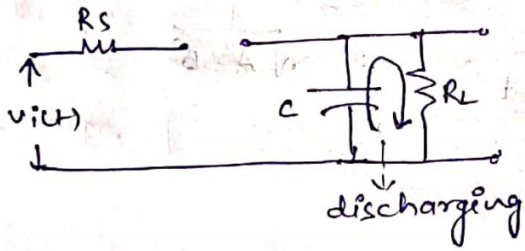


Here, the time constant $\tau_1 = R_S \cdot C$ should be very small so that capacitor rapidly charges to i/p voltage.

Case 2 :-

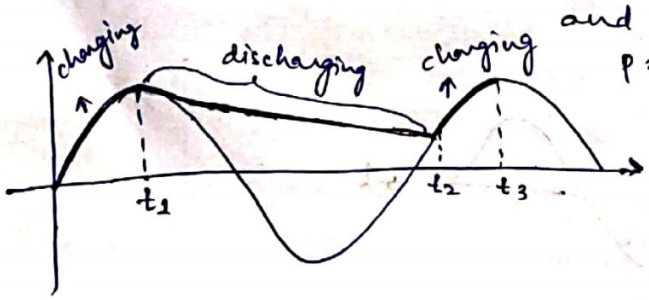
For $t = t_1^+$; ∵ voltage at p-side < voltage at n-side.

∴ diode is R.B ⇒ open circuit



Here, the time constant $\tau_2 = R_L \cdot C$ should be ~~~~ high so that capacitor discharges slowly.

Case 3 :- For $t = t_2^+$ to t_3 ⇒ diode again in F.B and same charging process repeats.



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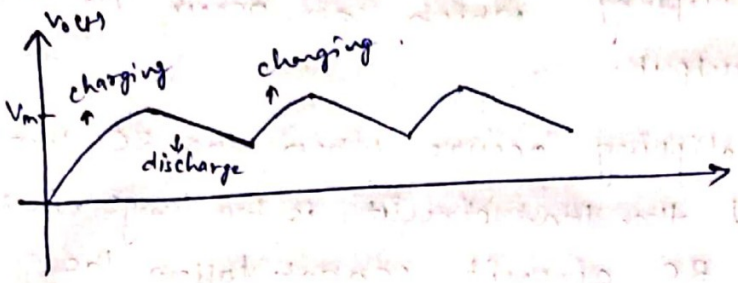
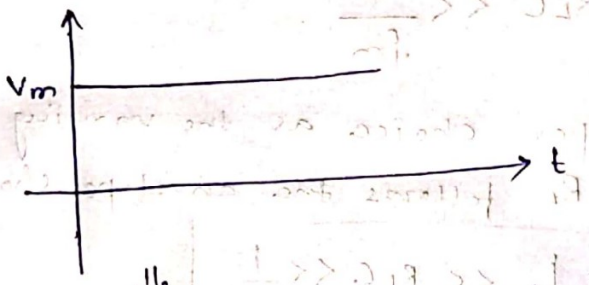
Now, voltage across capacitor which will be seen at o/p.



Now, we will pass this output through a smoothening filter to get smooth envelope of input.

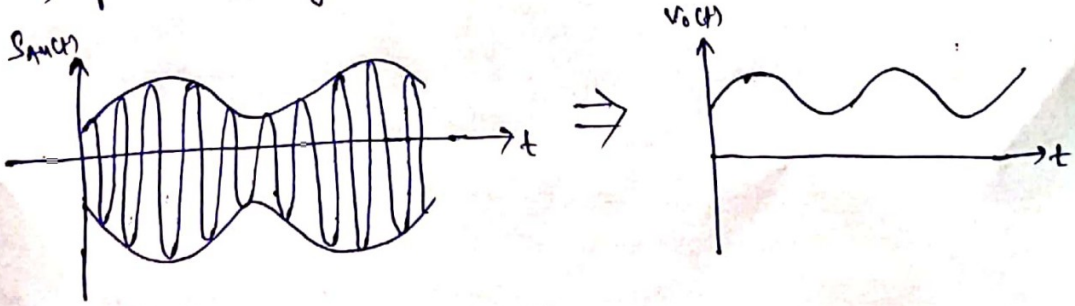


⇓

this is the final output for envelope detector.

Note:- To make capacitor voltage to follow the envelope of i/p signal, RsC should be very small & RLC should be very high.

Now, for AM signal as i/p:-



for AM signal, we have two different frequencies fc & fm where fc >> fm

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In Envelope detector, there is a distortion called "diagonal clipping" which can occur in the detector output.

⇒ Diagonal clipping occurs when the RC time constant of the load circuit is too large. Due to this the RC circuit cannot follow the fast changes in the modulating envelope.

∴ To avoid diagonal clipping

$$R_L C << \frac{1}{f_m}.$$

And, proper choice as the varying voltage across R_L follows the envelope should be:-

$$\boxed{\frac{1}{f_c} << R_L C << \frac{1}{f_m}}$$

If $R_L C$ is very small or $R_L C$ is very large, then in both cases we can't get the envelope of message signal waveform.

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Q:- Determine the minimum value of 'Ac' to get the +ve envelope of ~~input~~ amplitude modulate wave, given as:-

$$s(t) = A_c \cos\omega_c t + 2\cos\omega_c t \cos\omega_m t$$

or, $$s(t) = A_c \cos 2\pi f_c t + 2\cos 2\pi f_m t \cos 2\pi f_c t$$

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