Step voltage input to attenuator:

Consider source resistance is zero.

For t<0 , V_i = 0 V, so V_o = 0 V

At t = 0^+ , V_i = V volts(there is a sudden change in input voltage)

here an infinite current will flows through the capacitors C_1 and C_2 so some voltage will be existed across C_1 and C_2 .

Assume V1 and V2 are voltage across capacitors C_1 and C_2

By applying KVL , V = V1+V2

$V = q / C_1 + q / C_2$

$Vo(0^+) = V2 = q / C_2 = VC_1 / (C_1 + C_2)$

At t = ∞ (for t>0), capacitors are replaced with open circuit

So final output voltage $Vo(\infty) = V R_2 / (R_1 + R_2)$

We know for step input ,voltage at t = 0^+ and voltage at t = ∞ is same, similarly for perfect compensation output voltage at t = 0^+ and voltage at t = ∞ is must be same

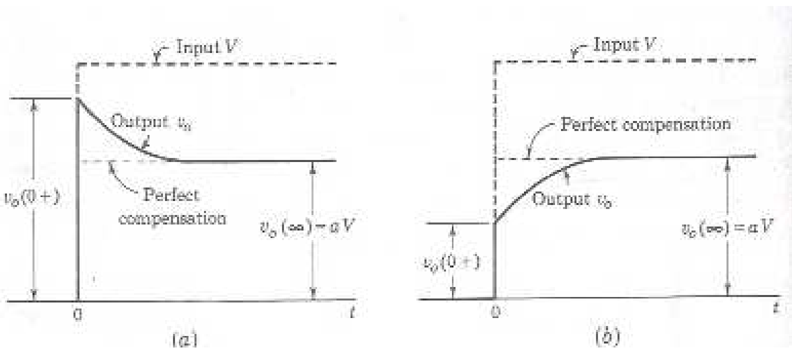
Then $Vo(0^+) = Vo(\infty)$

$VC_1 / (C_1 + C_2) = V R_2 / (R_1 + R_2)$

$\mathbf{R_1C_1 = R_2C_2}$

$C_1 = R_2C_2 / R_1 = C_P$

Where C_P is the required value of C_1 for perfect compensation.



If $C_1 > C_P$, the attenuator is said to be over compensated because initial output voltage is more compared to the final output voltage.

If $C_1 < C_P$, the attenuator is said to be under compensated because initial output voltage is small compared to the final output voltage.

Time taken by the over compensated or under compensated waveforms to reach its final value is 2.2 RC, where $R = R_1R_2/ R1+R2$ and $C = C_1 + C_2$.

Problems on attenuators:

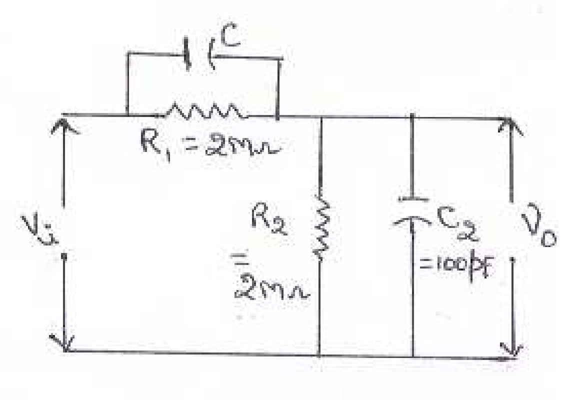
1. calculate and plot the output waveform for

(i) C = 100 PF (ii) C = 150 PF (i) C = 50 PF
Here input is 25V step.

We know For perfect compensation , $Cp = R_2C_2 / R_1 = 100$ PF
Case (i): C = 100PF =Cp
It represents attenuator is under perfect compensation. so

$Vo(0^+) = VC_1 / (C_1 + C_2) = Vo(\infty) = 12.5V$

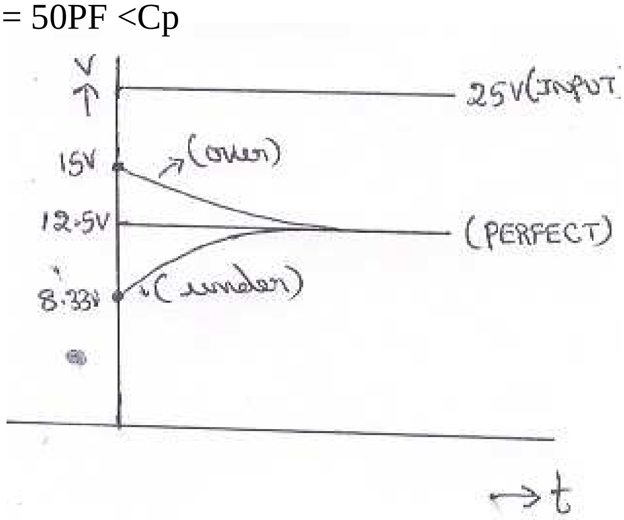
Case(ii): C = 150PF >Cp



It represents attenuator is under over compensation

So $Vo(0^+) = VC_1 / (C_1 + C_2) = 15$ V
And $Vo(\infty) = V R_2 / (R_1 + R_2) = 12.5$ V
Time taken by the over compensated waveform to reach its
Final value = 550 μsec

Case(ii): C = 50PF <Cp



It represents attenuator is under compensated.

So $V_o(0^+) = VC_1 / (C_1 + C_2) = 8.33$ V
And $V_o(\infty) = V R_2 / (R_1 + R_2) = 12.5$ V
Time taken by the under compensated waveform to reach its
Final value = 330 μsec