Power Management Integrated Circuits

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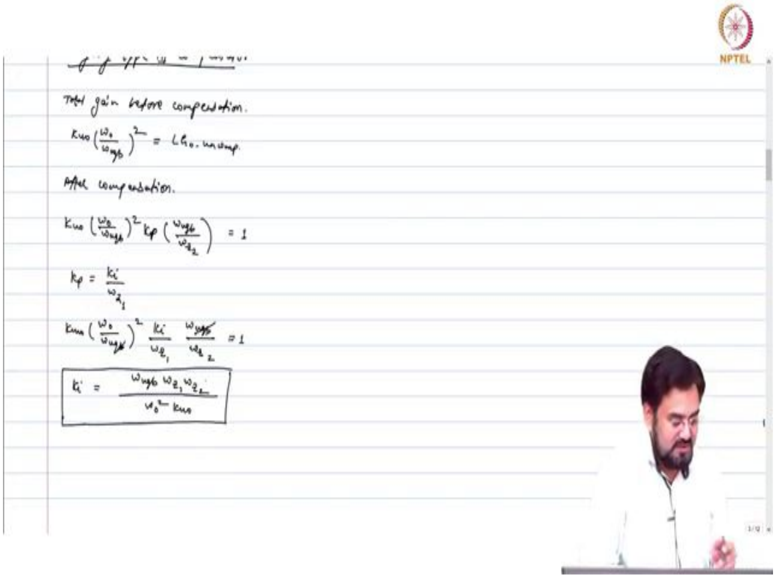
Lecture - 57

Type III Compensator using Op Amp-RC Architecture



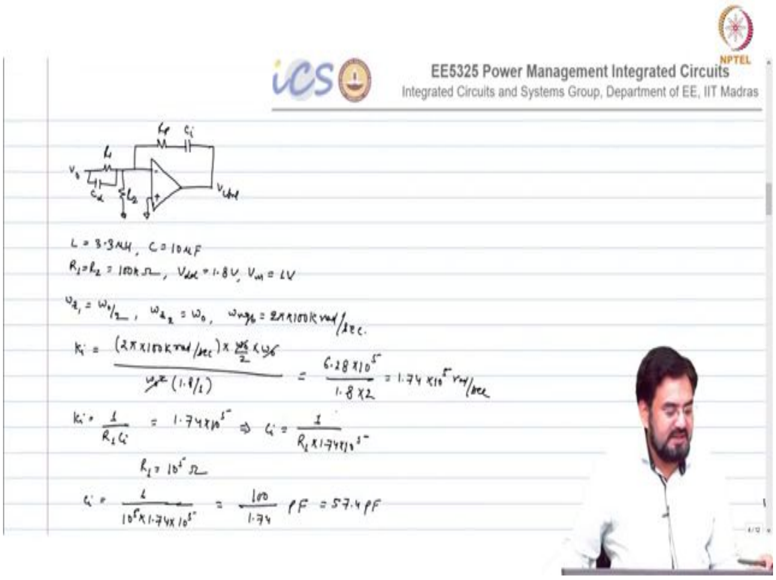
The loop gain after compensation at the ugb should be one. The gain before compensation in the converter is

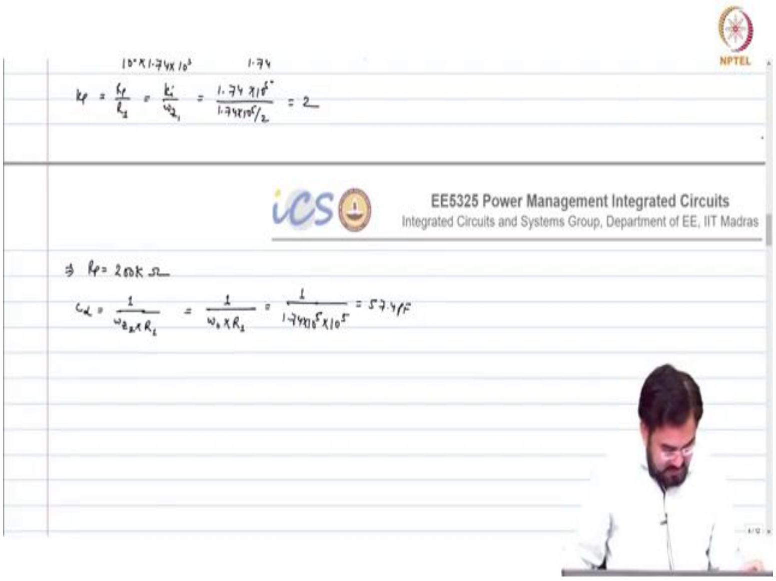
$$LG_{0-uncomp} = k_{u0}(\frac{\omega_0}{\omega_{ugb}})^2$$

Loop gain after compensation is

$$LG_{0-comp} = LG_{0-uncomp} * k_p(\frac{\omega_{ugb}}{\omega_{z2}}) = k_{u0}(\frac{\omega_0}{\omega_{ugb}})^2 k_p(\frac{\omega_{ugb}}{\omega_{z2}})$$

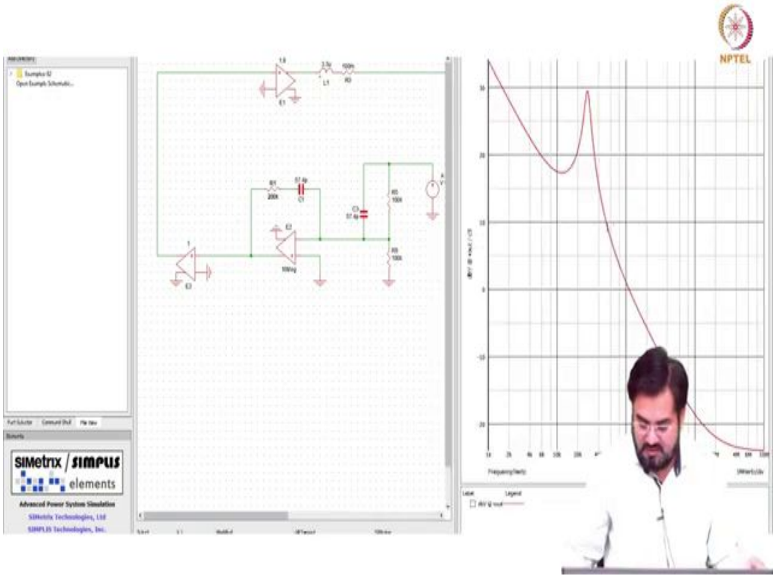
After comparing the loop gain after compensation to the unity we can find the value of k_p and k_i. The calculation for k_p and k_i is shown in the above image. So based on how we placed the zeros, we can get the value of the k_p and k_i.



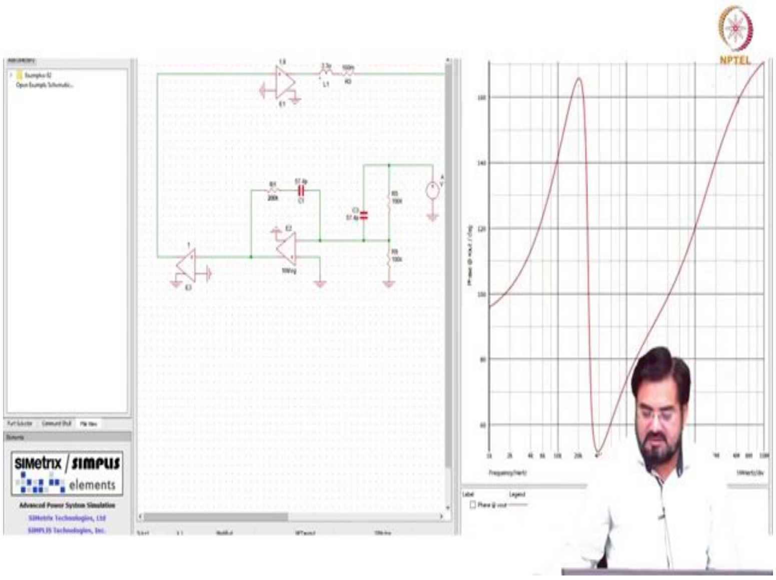


The above images show the example of type-III compensation using Opamp-RC. We have calculated the value of C_i, R_p, and C_d when the first zero is placed at half the value of LC frequency, and the second zero is placed at LC frequency.

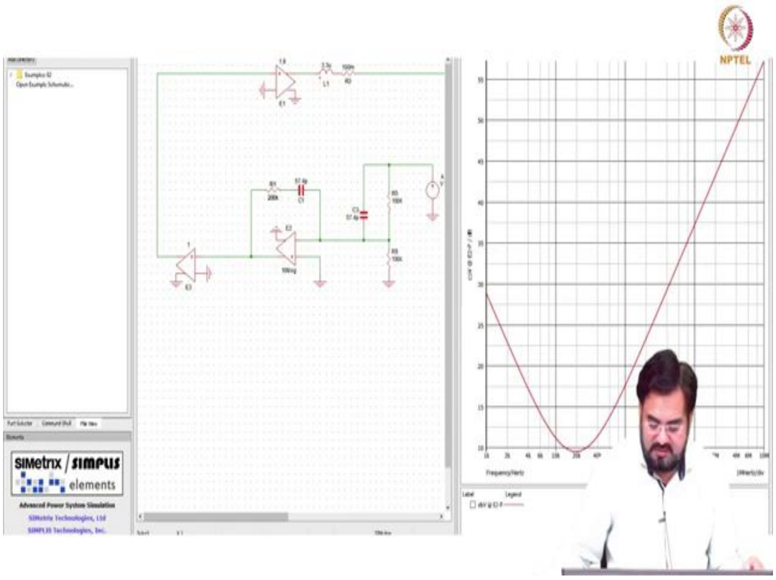
UGB is 100kHz and the phase margin will depend on the second zero and the Q factor. If the Q factor is very high then the phase will drop steeply at LC frequency and in the worst-case phase will drop 180° due to LC poles then it will not affect the phase margin and phase margin will only depend on the second zero.



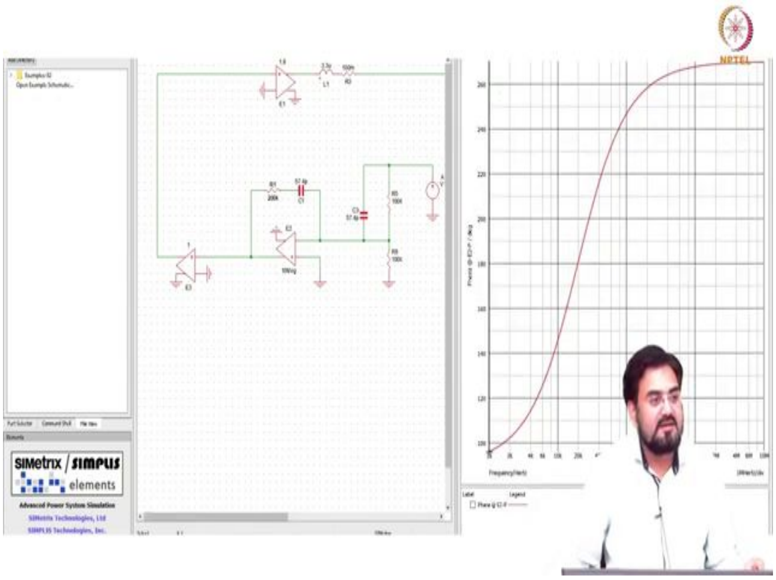
The above image shows the magnitude response of the loop gain of the converter in the above example with type-III compensation. UGB is around 110kHz.



The above image shows the phase response of the loop gain of the converter in the above example with type-III compensation. Phase margin is 75°. At infinite frequency, the phase will go to 180° because we also have an ESR zero which is at a very high frequency.



The above image shows the magnitude response at V_{ctrl} i.e. the magnitude response of Type-III compensator.



The above image shows the phase response at V_{ctrl} i.e. the phase response of Type-III compensator.