Power Management Integrated Circuits

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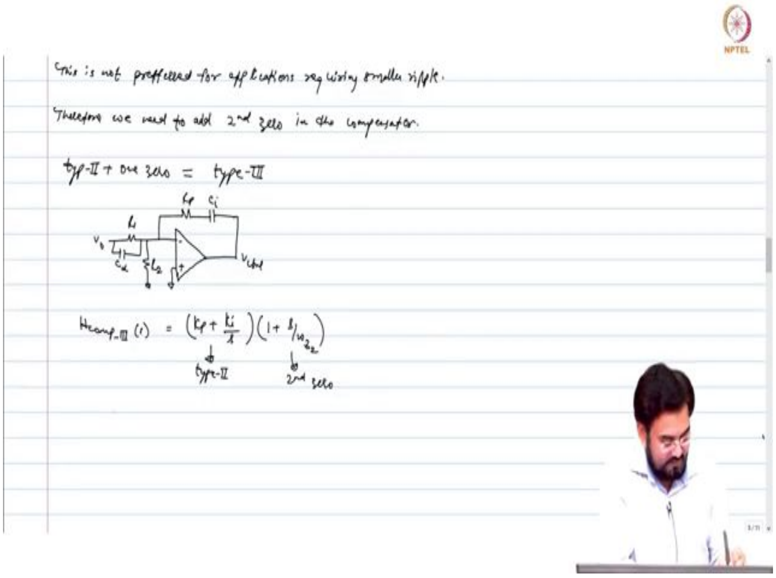
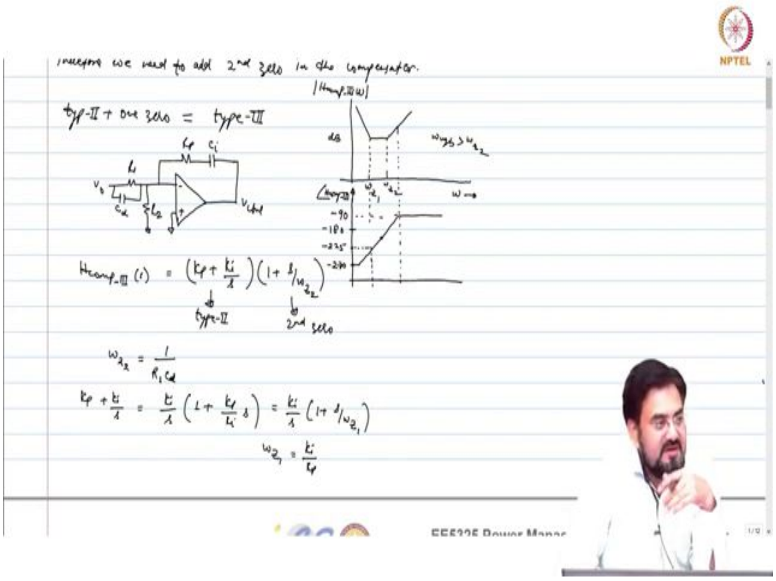
Lecture - 56
Introduction to Type- III Compensator



To get a type III compensator, we have to add one more zero in the type II compensator.The transfer function of type III compensator is

$$H_{Comp-III}(s) = H_{Comp-II}(s) * (1 + \frac{s}{\omega_{z2}}) = (k_p + \frac{k_i}{s})(1 + \frac{s}{\omega_{z2}})$$

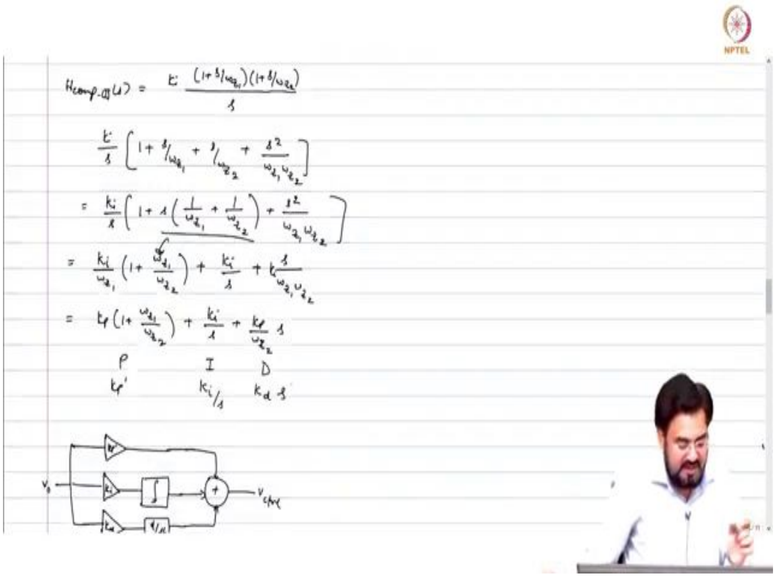


We have to add a capacitor in parallel with R_1 in the type II compensation circuit to add the extra zero. The circuit of Type -III compensator is shown in the above image. The value of the first zero and second zero will be

$$\omega_{z2} = \frac{1}{R_1 C_d}$$

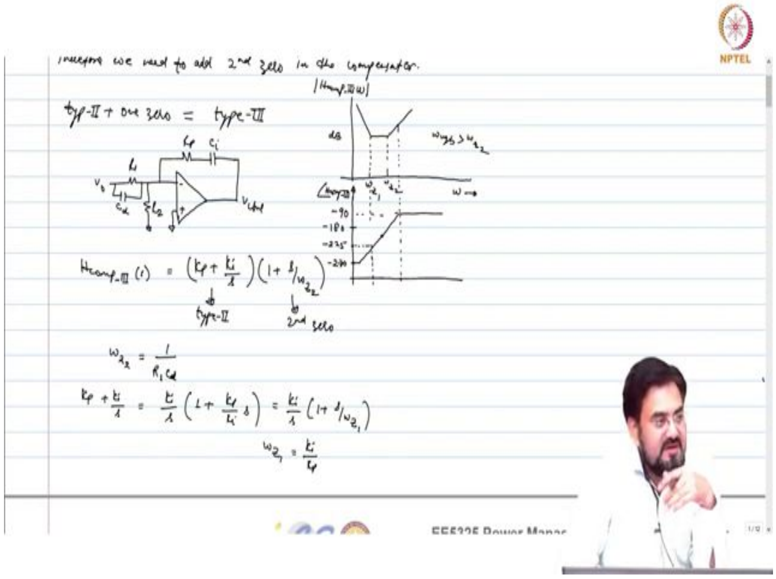
$$\omega_{z1} = \frac{k_i}{k_p}$$

We have one integrator and two zeros, the first zero will cancel the integrator and the second zero will give the phase boost which we were getting from ESR zero in type-II compensation. Ripple will not change because ESR zero is replaced with the ω_{z2}.



As you can see in the above image, we can simplify the transfer function of type-III compensator and separate out the proportional, integral, and derivative terms. Type-III is also called as PID. As you can see in the figure in the above image, we can also design PID by making separate paths for proportional, integral, and derivative and then adding them. We can control PID parameters individually in this case but op-amp requirements will increase whereas in the previous case PID parameters are interdependent on each other.

We cannot directly tell if the system is stable by looking at the value of k_p,k_i, and k_d. We understand the behavior of the system better in terms of bode plot compared to PID parameters. We have to calculate the value of poles,zeroes and gain using the values of k_p,k_i, and k_d to check the stability of the system.



The above image shows the phase and magnitude response of the type-III compensator. We have already discussed the placement of zeroes in type-II compensation.