Power Management Integrated Circuits
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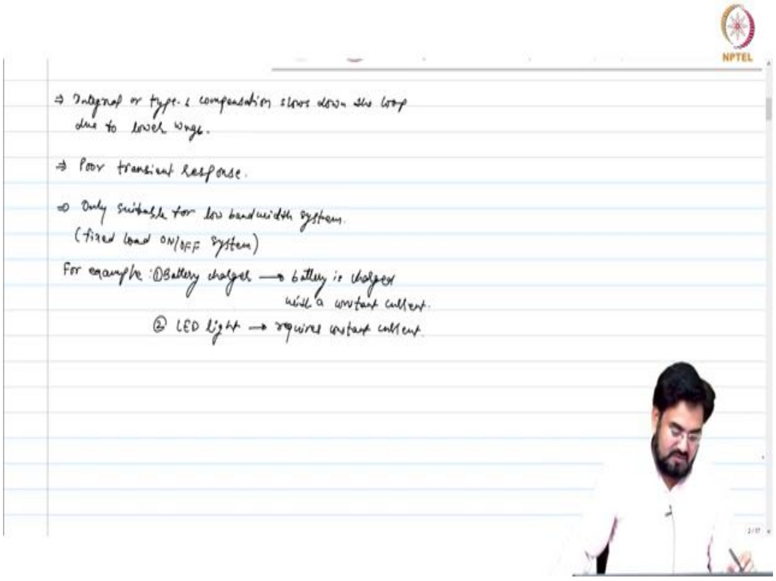
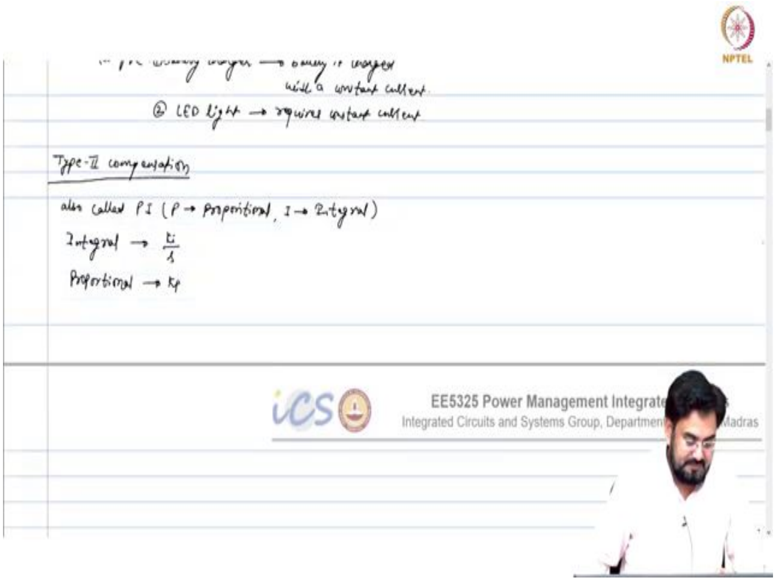
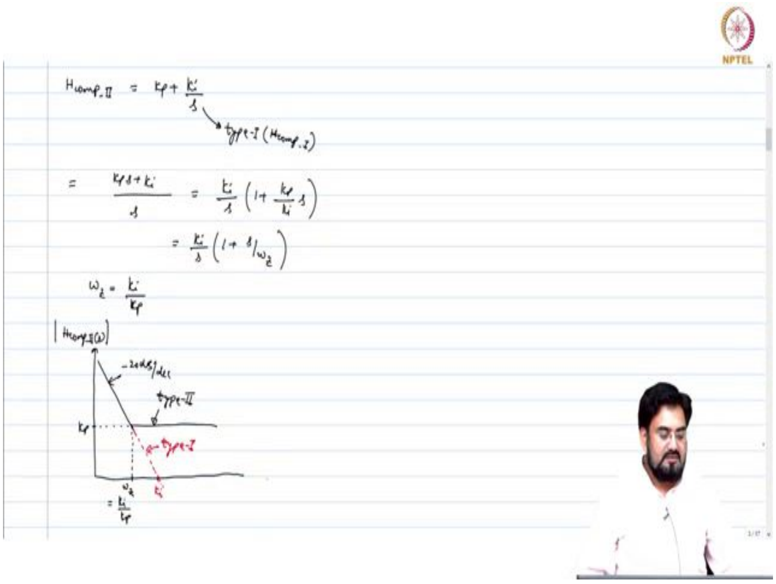
Lecture - 51
Introduction to Type-II Compensation



Type I compensation is only suitable for a slow system because the bandwidth is low. For example battery charger and LED lights. LED light draw fix current so there is no fast changing load. But the load is variable in most of our system and if the voltage goes below regulation when a transient occurs then it may even shut down our system. We need to increase the ugb for better transient response and if we increase the ugb then LC poles will come inside the ugb. We have 3 poles inside the ugb, one is of the integrator, and two are LC poles and to compensate this we need to add two zeroes.



The type of system depends on the number of integrators it contains. For example, the Type-I system contains one integrator, the Type-II system contains two integrators, etc. So to compensate for a Type-II system we require Type II compensation which contains one zero. So we can say that the Type-II and Type-III compensator contains one zero and two zeroes respectively. Type-II system is also called PI system where P stands for proportional, and I stands for integral.



We can transfer write the function of Type-II compensator as

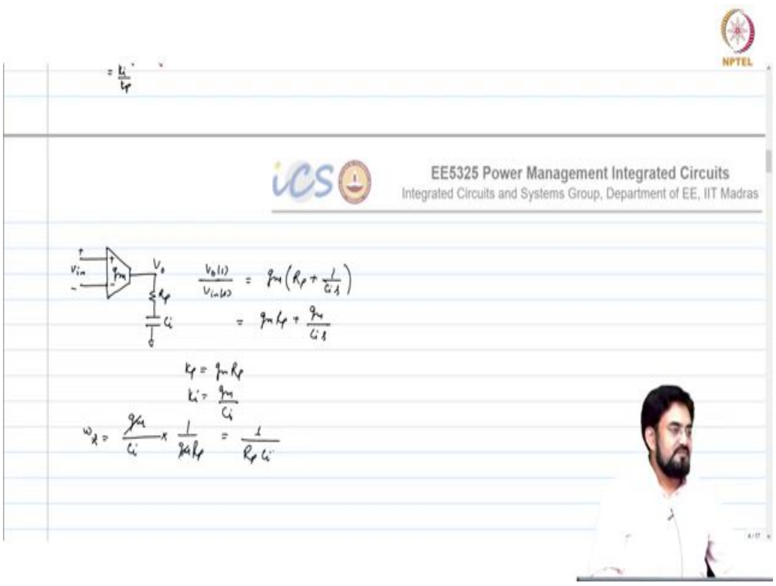
$$H_{COMP-II}(s) \ = \frac{K_i}{s} + K_p$$

Where k_i is the integral constant and k_p is the proportional constant. k_i/s is the transfer function for Type-I compensator and we added the proportional term to make it a Type-II compensator. We can simplify it further and write it as :

$$H_{COMP-II}(s) \ = \frac{K_i}{s}(1 + \frac{K_p}{K_i}s) \ = \frac{K_i}{s}(1 + \frac{s}{\omega_z})$$

where $\omega_z = k_i/k_p$

The magnitude response of the $H_{COMP-II}(s)$ is shown in the above image. We can see that the dc gain is infinite and gain after zero is k_p. So the gain after the zero will change after changing k_p and this will also move zero. If we keep increasing the zero frequency value then gain will decrease after zero frequency.



To make a type II Gm-C compensator, we need a Gm-C integrator and to add an extra zero we need to connect a resistance in series with the integrator capacitor. The circuit diagram of type II Gm-C compensator is shown in the above image.

The transfer function of type II Gm-C compensator will be

$$\frac{V_0(s)}{V_{IN}(s)} = g_m R_p + \frac{g_m}{C_i s}$$

After comparing it with $H_{COMP-II}(s)$:

$$K_p = g_m R_P$$

$$K_i = \frac{g_m}{C_i}$$

$$\omega_z = \frac{1}{R_p C_i}$$

If we want to change the value of k_p, then we should change R_p because it will not change the value of k_i. If we change g_m to change the proportional gain then the integral curve will change and zero frequency will remain the same but if we don't want to change the integral curve then we should change R_p to change the proportional gain.