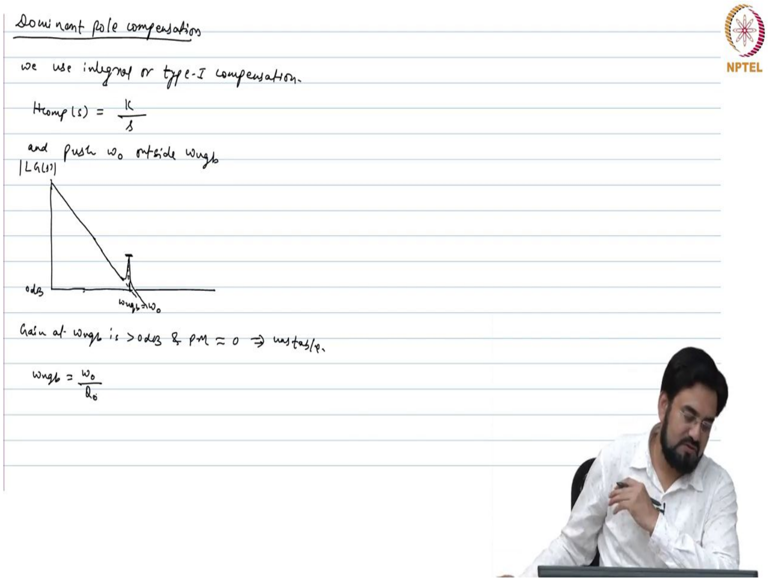
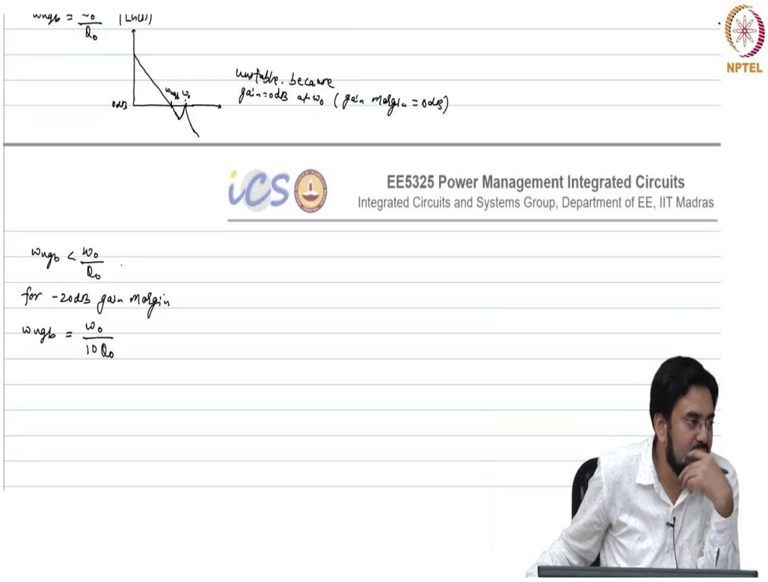
Power Management Integrated Circuits
Dr. Qadeer Ahmad Khan
Department of Electrical Engineering
Indian Institute of Technology, Madras

Lecture - 49
Dominant Pole Compensation
(Type-I with Gm- C Architecture)

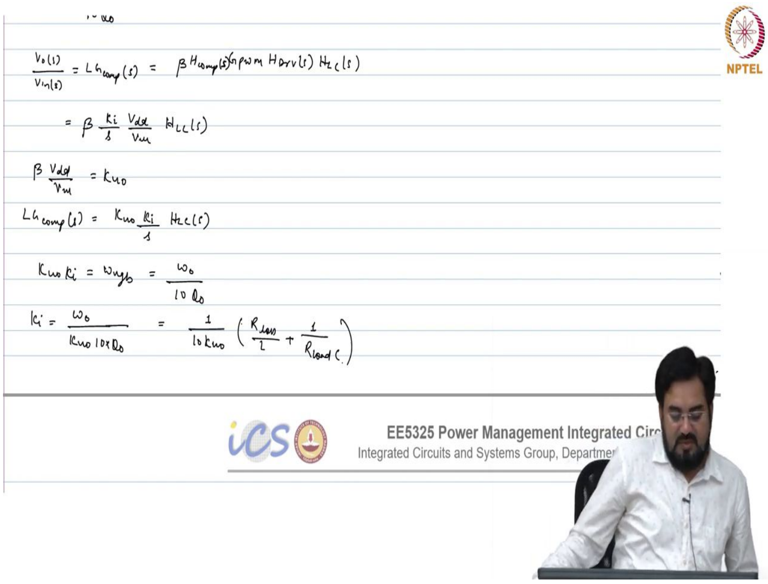


In Dominant pole compensation, we use $H_{COMP}(s)$ as an integrator or type I compensator. So, $H_{COMP}(s)$ will be equal to k/s and we will push ω_0 outside ω_{ugb}. How far we need to push ω_0 outside ω_{ugb} depends on the Q factor.

Let us say we make ω_0 equal to ω_{ugb}. If there is not any Q factor then gain should have crossed 0dB at ω_{ugb} but due to the Q factor gain at ugb does not remain 0 dB and its more than 0db and the phase there is almost touching -180°. The system is unstable because gain at ω_{ugb} is more than 0dB and the phase margin is almost zero.



Let us say we make ω_{ugb} equal to ω_0/Q_0. Gain at ω_{ugb} will be 0dB but gain at ω_0 will also be 0dB because of the Q factor and phase at ω_0 will be almost -180°. The system is again unstable because the gain at ω_0 is more 0dB and the phase margin is almost zero. Gain at ω_0 equal to 0dB means gain margin is 0dB. So for a stable system ω_{ugb} should be less than ω_0/Q_0 and for -20dB gain margin ω_{ugb} should be equal to $\omega_0/10Q_0$.



Putting the value of $H_{COMP}(s)$ in $LG_{COMP}(s)$.

$$LG_{COMP}(s) = \beta \frac{k_i}{s} \frac{Vdd}{V_m} H_{LC}(s)$$

Assume

$$k_{u0} = \beta \frac{Vdd}{V_m}$$

then

$$\omega_{ugb} = k_{u0}\, k_i = \frac{\omega_0}{10Q_0}$$

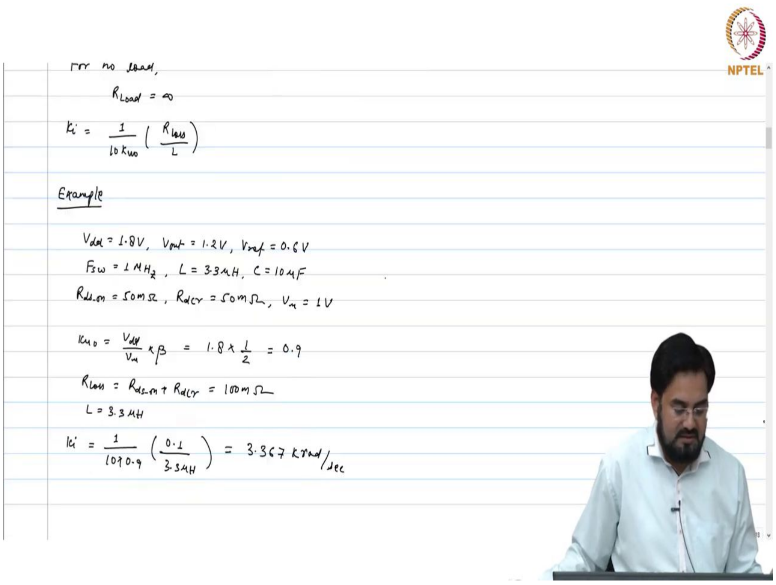
We know the value of ω_0 and Q_0. So from the above equation, we can find the value of k_i.

$$k_i = \frac{1}{10k_{u0}}\left(\frac{R_{LOSS}}{L} + \frac{1}{R_{LOAD}C}\right)$$

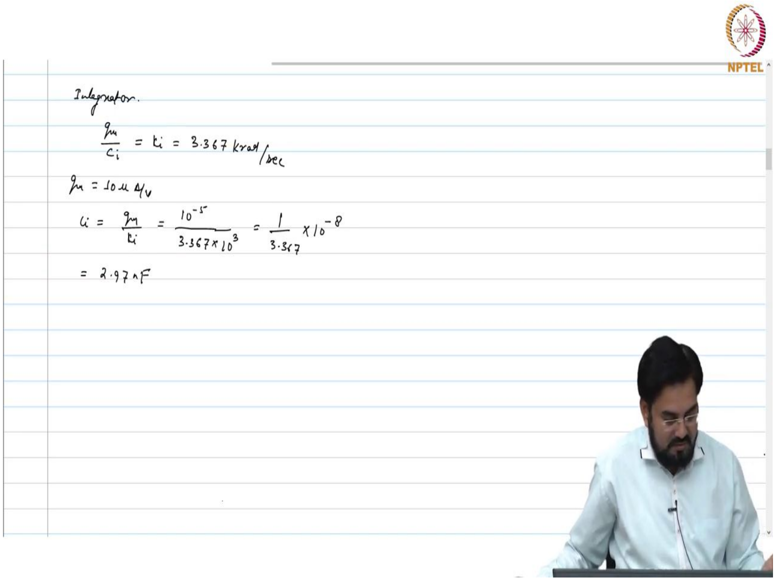
For No load

$$k_i = \frac{1}{10k_{u0}} \times \frac{R_{LOSS}}{L}$$

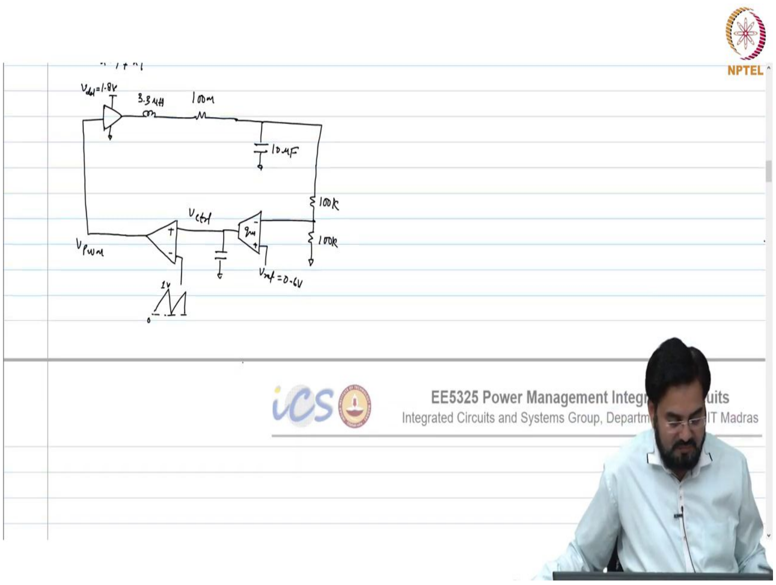
We will be modeling the sample system in continuous time because it is easy to model in continuous time. We will first design in the continuous model according to the specifications then convert it into sampled system. In the dominant pole compensation case we have to find the value of k_i.



In the example in the above image value of k_i in no load condition is calculated and its value is 3.367 krad/sec.



If we use Gm-C integrator with gm of 10 uA/V for k_i of value 3.367 krad/sec then we will need a capacitor of value 2.97nF.



The above image shows the final circuit.