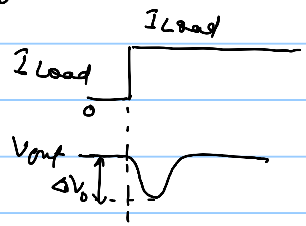
<u>Case - 1</u> : Load Transient is limited by bandwidth.

Using 1^{st} order approximation.

time constant (in closed loop)

$$\tau = \frac{1}{\omega_{ugb}} = \frac{1}{2\pi f_{ugb}}$$

$\tau \rightarrow$ loop delay



$$I = C \frac{dV_0}{dt}$$

$$dt = \tau, \quad I = I_{Load}$$

$$\Delta V_0 = dV_0 = \frac{I}{C} \times \tau = \frac{I_{Load}}{2\pi f_{ugb} C}$$

$$f_{ugb} = F_{sw}/10 = 1\,MHz$$

$$C = 0.34\,\mu F, \quad I_{Load} = 1A$$

$$\Delta V_0 = \frac{1}{2\pi(1\cancel{0^6})(0.34)\times\cancel{10^{-6}}} = \frac{1000}{2}\,mV \approx 500\,mV$$

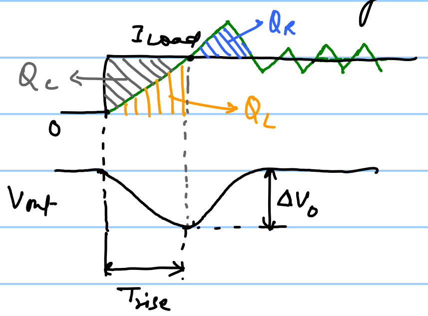
spec for $\Delta V_0 < 5\%$ of V_{out}

$\Delta V_0 = 5\% \cdot 1.2V = 60\,mV$

C required will be approx. 10x more to meet $\Delta V_0 < 60\,mV$

$C = 10 \times 0.34\,\mu F = 3.4\,\mu F$

<u>Case-2</u>: Load transient is limited by inductor slew rate (BW is very high → non-linear control)



Q_c → charge supplied by the capacitor before $I_L = I_{Load}$

Q_L → " " " " Inductor. " "

Q_R → Recovery charge to bring Vout back to final value (supplied by the inductor)

Q_c = Area under the triangle.

$$= \frac{1}{2} T_{rise} \times I_{Load} \quad — (1)$$

$$\Delta I_L = \frac{V_{dd} - V_0}{L} \times T_{rise} = I_{Load}$$

$$T_{rise} = I_{Load} \times \frac{L}{V_{dd} - V_0} \quad — (2)$$

Substitute in (1)

$$Q_c = \frac{1}{2} I_{Load}^2 \times \frac{L}{V_{dd} - V_0}$$

$$Q_c = CV = C \Delta V_0$$

$$\boxed{\Delta V_0 = \frac{Q_c}{C} = \frac{1}{2} \frac{I_{Load}^2}{(V_{dd} - V_0)} \left(\frac{L}{C}\right)}$$

$I_{load} = 1A, \quad L = 165\,nH, \quad V_{dd} = 1.8V, \quad V_o = 1.2V$

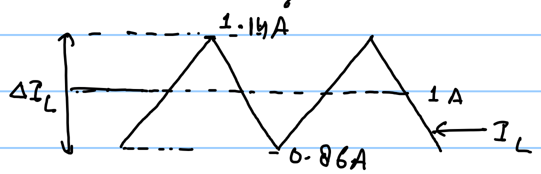
$$\Delta V_o = \frac{1}{2}\,\frac{1}{0.6} \times \frac{0.165 \times \cancel{10^{-6}}}{0.34 \times \cancel{10^{-8}}} \approx 400\,mV$$

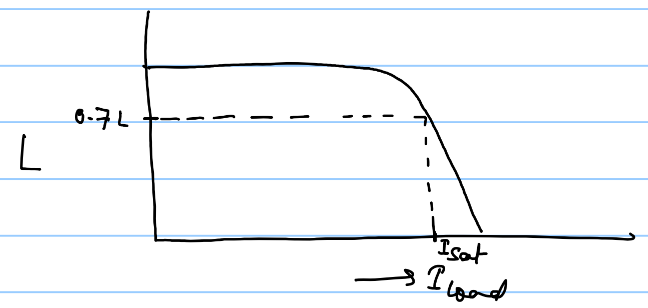
$C = 0.34\,\mu F$ is not sufficient to meet $\Delta V_o < 60\,mV$ spec.

$L = 165\,nH$

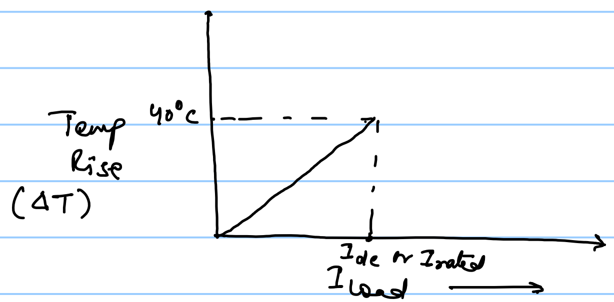
$$\Delta I_{L(max)} = \frac{V_{dd}\,D(1-D)}{L} \times T_{sw} \Big|_{\text{at } D = 0.5}$$

$$= \frac{1.8 \times 0.25}{165 \times \cancel{10^{-9}}} \times 100 \times \cancel{10^{-9}} \approx 0.27\,A$$





L
0.7L
Isat
ILoad



Temp
Rise
(ΔT)
40°c
Idc or Irated
ILoad