Example Analysis

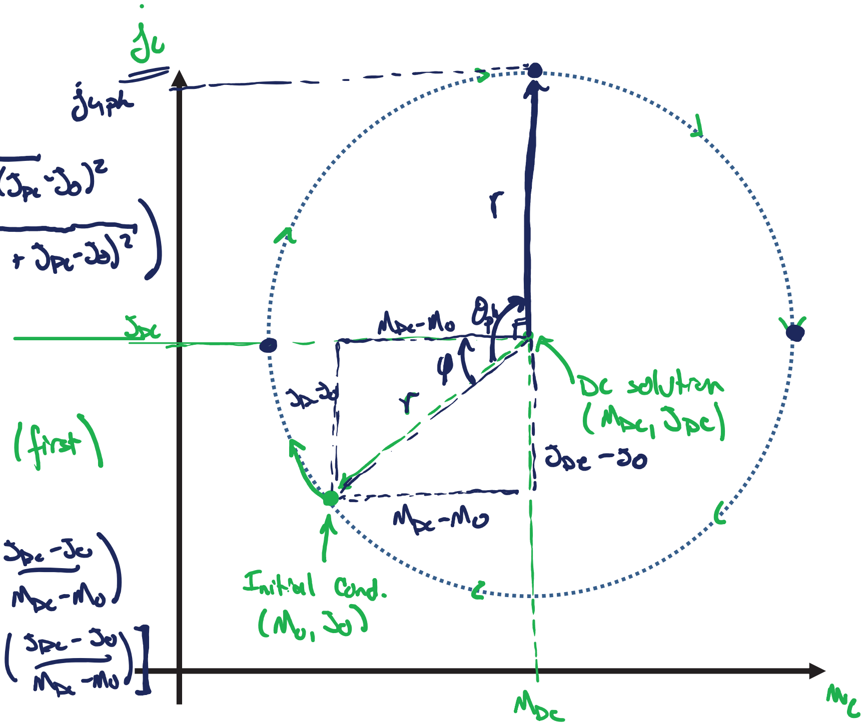
What is i_{Lpk} ?

$$j_{Lpk} = \frac{i_{Lpk}}{I_{base}} = \frac{i_{Lpk}}{V_{base}/R_o}$$

$$j_{Lpk} = J_{DC} + r$$

$$j_{Lpk} = J_{DC} + \sqrt{(M_{DC}-M_0)^2 + (J_{DC}-J_0)^2}$$

$$i_{Lpk} = \frac{V_{base}}{R_o}\left(J_{DC} + \sqrt{(M_{DC}-M_0)^2 + (J_{DC}-J_0)^2}\right)$$



When (t) does i_{Lpk} occur? (first)

$$\theta_{pk} = \omega_0 t_{pk}$$

$$\theta_{pk} = \frac{\pi}{2} + \varphi = \frac{\pi}{2} + \tan^{-1}\left(\frac{J_{DC}-J_0}{M_{DC}-M_0}\right)$$

$$t_{pk} = \frac{\theta_{pk}}{\omega_0} = \frac{1}{\omega_0}\left[\frac{\pi}{2} + \tan^{-1}\left(\frac{J_{DC}-J_0}{M_{DC}-M_0}\right)\right]$$

State Plane Algorithm

Manipulate circuit into ac equivalent w/ 1L, 1C & (possibly) DC sources, only.

– May require some approximation

(1) Normalize waveforms & time

V_{base} = anything, you choose

$$I_{base} = \frac{V_{base}}{R_o}$$

$$M_x(t) = \frac{V_x(t)}{V_{base}}$$

$$j_x(t) = \frac{i_x(t)}{I_{base}}$$

$$\theta_x = \omega_0 t_x$$

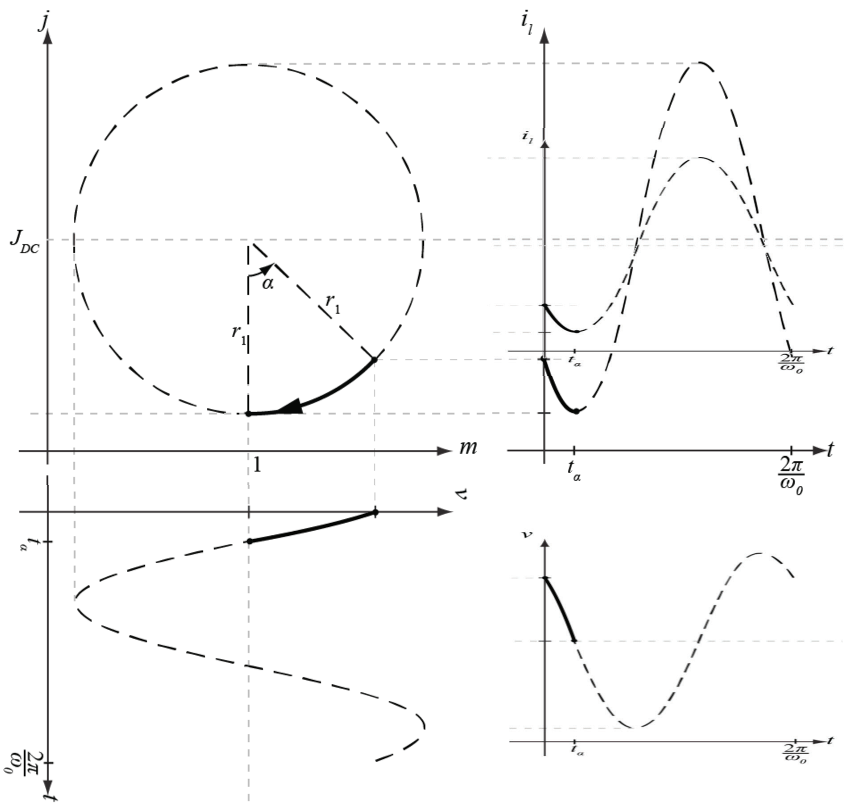
(2) Plot trajectory on the M_C-j_L axes

Form a circle

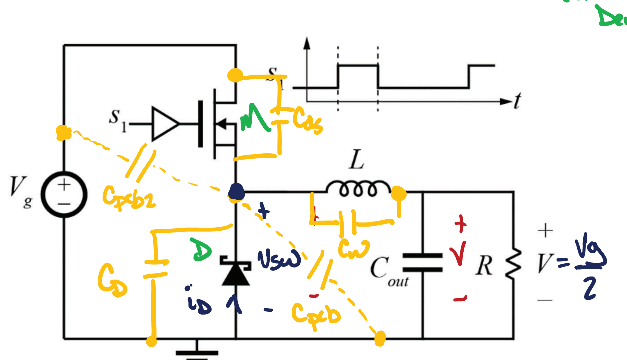
- center at (M_{DC}, J_{DC}) → the DC solution
- point on circle at (M_0, J_0) → initial condition
- Direction of state plane comes from i.c. on ~~first derivative~~

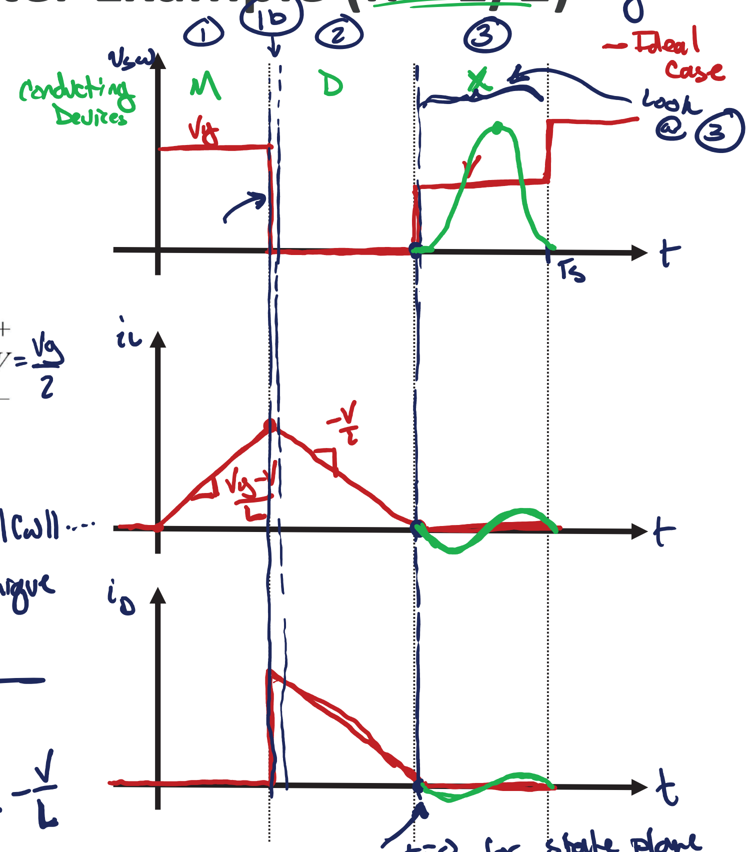
(3) Solve parameters of interest on state plane

(4) Denormalize

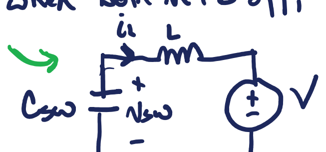


DCM Buck Converter Example (M=1/2) $= \frac{V}{V_g}$





when both M & D off, ac equivalent:



$C_{sw} = C_{ds} \| C_D \| C_w \| \ldots$

← not unique

DC solution

$v_{sw} = V$

$i_L = 0$

Initial Conditions

$$@_{t=0} \begin{cases} v_{sw} = 0 \\ i_L = 0 \\ \frac{dv_{sw}}{dt} = 0 \quad \frac{di_L}{dt} = -\frac{V}{L} \end{cases}$$