

Announcements

- No Lecture Wednesday

Resonant Power Conversion

Erickson and Maksimovic, Chapter 19

- Resonant inverters used in induction heating, gas-discharge lamp ballast, electrosurgical generators where sinusoidal waveforms of high peak value are needed
- Resonant DC-DC converters popular in high frequency and high voltage applications where parasitics of transformer are significant

Advantages:

- Absorbed parasitics
- Soft-switching (ZVS or ZCS) over a wide range possible

Disadvantages:

- Difficult to design resonant elements
- Control can be complex
- Higher peak current stresses
- High circulating current at light load

DAB: Reduced C_r

Series Resonant Converter

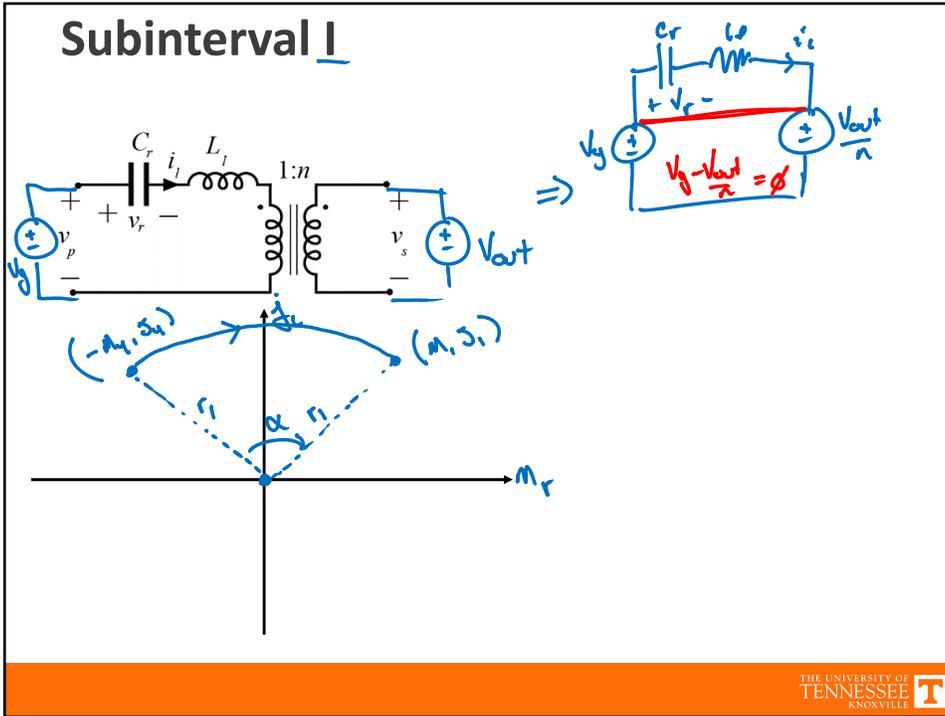
phase-shift modulation

First consider $V_{out} = nV_g$

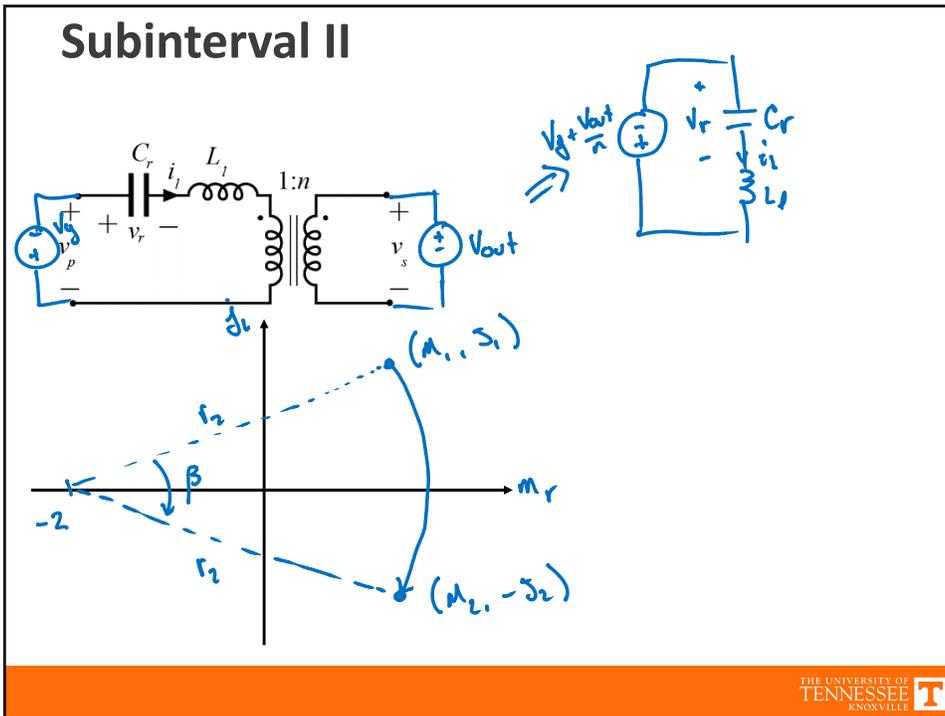
→ Neglect C_{ds} of all devices, look at $m_r - f_c$ state plane

$V_{base} = V_g$ $R_0 = \sqrt{\frac{L_r}{C_r}}$

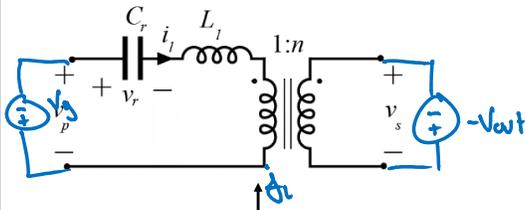
Subinterval I



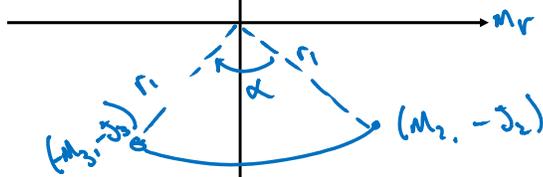
Subinterval II



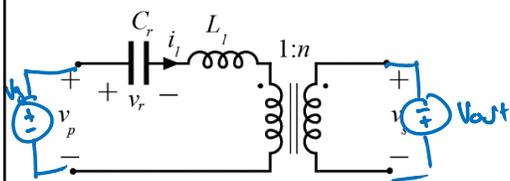
Subinterval III



* Same as (I)
but negative



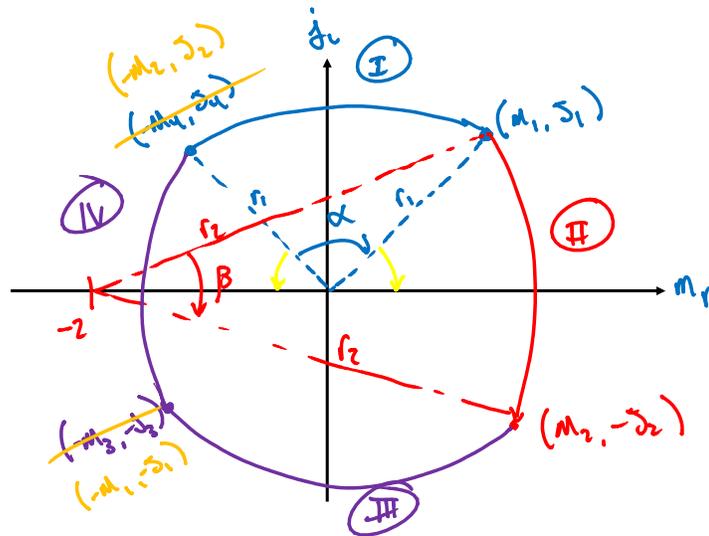
Subinterval IV



* Same as (I)
but negative



Complete State Plane – Phase Shift Modulation



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$$\textcircled{I} : r_1^2 = m_2^2 + \omega_2^2 = m_1^2 + \omega_1^2$$

$$\alpha = \pi - \tan^{-1}\left(\frac{\omega_1}{m_1}\right) - \tan^{-1}\left(\frac{\omega_2}{m_2}\right)$$

$$\textcircled{II} : r_2^2 = (2 + m_1)^2 + \omega_1^2 = (2 + m_2)^2 + \omega_2^2$$

$$\beta = \tan^{-1}\left(\frac{\omega_1}{2 + m_1}\right) + \tan^{-1}\left(\frac{\omega_2}{2 + m_2}\right)$$

$$\begin{array}{r} +m_1 \\ - \end{array} \frac{(4 + 4m_1 + m_1^2) + \omega_1^2}{m_1^2 + \omega_1^2} = \frac{(4 + 4m_2 + m_2^2) + \omega_2^2}{m_2^2 + \omega_2^2}$$

$$4 + 4m_1 = 4 + 4m_2$$

$$\therefore m_1 = m_2$$

$$\phi \quad \omega_1 = \omega_2$$

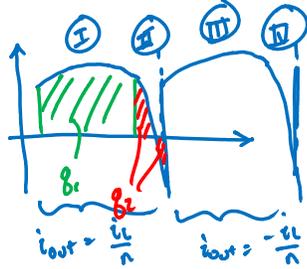
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Averaging Step

$$\frac{T_s}{2} = t_1 + t_2 \rightarrow$$

$$\frac{T}{F} = \alpha + \beta$$



$$n \langle i_{out} \rangle = \frac{2}{T_s} \int_0^{T_s/2} i_c dt$$

$$= \frac{2}{T_s} [g_1 + g_2]$$

$$g_1 = C_r (V_1 + V_2) = 2C_r V_1$$

$$g_2 = C_r (V_1 - V_2) = \phi$$

$$n \langle i_{out} \rangle = \frac{2}{T_s} (2C_r V_1)$$

$$J = \frac{n \langle i_{out} \rangle}{I_{base}} = \frac{F}{\pi} 2 M_1$$